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Complete List of Authors:	Khalequzzaman, Md. ; Bangabandhu Sheikh Mujib Medical University, Department of Public Health and Informatics Chiang, Chifa; Nagoya University School of Medicine, Department of Public Health and Health Systems Choudhury, Sohel Reza; National Heart Foundation Hospital and Research Institute, Department of Epidemiology and Research Yatsuya, Hiroshi; Fujita Health University School of Medicine, Department of Public Health; Nagoya University School of Medicine, Department of Public Health and Health Systems Al-Mamun, Mohammad; National Heart Foundation Hospital and Research Institute, Department of Epidemiology and Research Al-Shoaibi, Abubakr; Nagoya University School of Medicine, Department of Public Health and Health Systems Hirakawa, Yoshihisa; Nagoya University School of Medicine, Department of Public Health and Health Systems Hoque, Bilqis; Environment and Population Research Center Islam, Syed; Bangabandhu Sheikh Mujib Medical University, Department of Public Health and Informatics Matsuyama, Akiko; Nagasaki University School of Tropical Medicine and Global Health Iso, Hiroyasu; Osaka University Public Health Graduate School of Medicine Aoyama, Atsuko; Nagoya University School of Medicine, Department of Public Health and Health Systems
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Non-communicable disease risk factors among the urban poor in Bangladesh

Md. Khalequzzaman[1], Chifa Chiang[2], Sohel Reza Choudhury[3], Hiroshi Yatsuya[2, 4], Mohammad Abdullah Al-Mamun[3], Abubakr Ahmed Abdullah Al-Shoaibi[2], Yoshihisa Hirakawa[2], Bilqis Amin Hoque[5], Syed Shariful Islam[1], Akiko Matsuyama[6], Hiroyasu Iso[7], and Atsuko Aoyama[2*]

[1] Department of Public Health and Informatics, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

[2] Department of Public Health and Health Systems, Nagoya University School of Medicine, Nagoya, Japan

[3] Department of Epidemiology and Research, National Heart Foundation Hospital and Research Institute, Dhaka, Bangladesh

[4] Department of Public Health, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

[5] Environment and Population Research Center, Dhaka, Bangladesh

[6] Nagasaki University School of Tropical Medicine and Global Health, Nagasaki, Japan

[7] Public Health Graduate School of Medicine, Osaka University, Suita, Osaka, Japan

*Corresponding author: Atsuko Aoyama, MD, PhD

Department of Public Health and Health Systems, Nagoya University School of Medicine

65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan

e-mail: atsukoa@med.nagoya-u.ac.jp

telephone: +81-52-744-2108

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ABSTRACT

Objectives: This study aims to describe non-communicable disease (NCD) risk factor prevalence of the urban poor in Bangladesh.

Design: We conducted a community based cross-sectional epidemiological study.

Setting: The study site was an urban poor community in Dhaka. Based on a census-like baseline survey, we found that there were 8604 households with 34 170 residents, and that household wealth levels could be categorized into two groups.

Participants: The study targeted 18-64 year old residents in the community. Stratified random sampling was applied to select equal number of men and women from each household wealth stratum. A total of 2551 residents participated in the questionnaire survey, and 2009 participated in the subsequent physical measurements and blood tests.

Outcome measures: A modified WHO STEPS instrument was used, including a structured questionnaire for behavioral risk factors, physical measurements, and blood tests. The prevalence of NCD risk factors, including obesity, hypertension, diabetes, and tobacco use, and differences by gender and household wealth levels were statistically analyzed.

Results: About 60% of men and 22% of women were current tobacco users, but cigarette smoking was only reported from men (52%). Most of them (92%) consumed more than 1 serving of fruit and vegetables per day, however, only 2% had more than 5 servings. Overweight/obesity was more common in women (39%) than in men (19%), while underweight was more common in men (21%) than in women (7%). Prevalence of hypertension was 19% in men and 21% in women. Prevalence of diabetes was 15% in men and 22% in women, much higher than the estimated national prevalence (7%). The prevalence of raised total cholesterol was 20% in men and 26% in women, respectively.

Conclusions: The study identified diabetes, hypertension, tobacco use, and both overweight and underweight were prevalent among the urban poor in Bangladesh.

Strengths and limitations of this study:

- This study is the first population based survey including measurement of glycated hemoglobin (HbA1c) and blood lipid profile in Bangladesh.
- This study targeted the urban poor, the underserved high risk population, using representative sampling methods.
- Analyzing blood samples by comprehensive automatic equipment in a reliable clinical laboratory, but not by portable device often used for STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as measurement of HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count.
- This study targeted only one urban poor community, which may not represent nationwide situation.
- Targeting poor people, we could not measure fasting blood samples, but measured HbA1c as a useful alternative.

INTRODUCTION

Non-communicable diseases (NCDs) are globally recognized threats, thus reducing the burden of NCDs has been included as one of the targets of the Sustainable Development Goals [1]. NCDs are new priorities and additional burdens on health in low and middle income countries, where urbanization and lifestyle changes are advancing rapidly. In addition, low birth weight and childhood malnutrition among the poor may increase the risks of cardiovascular diseases and diabetes in adulthood [2, 3].

Bangladesh is a lower-middle income country in South Asia, with over 160 million population in 2015 [4]. While infectious diseases are still prevalent, the burden of NCDs is also increasing even among the poor [5]. Population-based NCD risk factor surveys by a standardized method of the World Health Organization (WHO), *i.e.* STEPwise approach to surveillance (STEPS) [6], were conducted four times in the past in Bangladesh [7-11]. However, blood glucose and total cholesterol were measured only in the 2006 survey. Population-based survey on blood lipid profile including high-density lipoprotein (HDL)-cholesterol and low-density lipoprotein (LDL)-cholesterol and triglycerides have never been conducted.

Urban population in Bangladesh is rapidly increasing, as indicated by 3.4% annual urban population growth in comparison with 1.2% in the whole nation [4]. The urban poor population is expanding rapidly and the burden of NCDs is increasing as well, due to the lifestyle changes and possible childhood undernutrition of the urban poor. However, the situation of NCDs and their risk factors among the urban poor have not known yet, and data and information on prevalence of NCD risk factors are mostly unavailable.

We conducted a cross-sectional epidemiological study on NCD risk factors applying a modified WHO STEPS procedure, and a qualitative study on perception and attitude towards NCD risk factors among the people in a poor community in Dhaka, Bangladesh. This paper aims to describe the epidemiological profile of the urban poor, with regard to prevalence of NCD risk factors and differences by gender and household wealth levels.

METHODS

Study site and study population

We conducted the study in Bauniabadh, an urban poor community in Dhaka, Bangladesh [12]. The community was originally established by the government in 1972 as a settlement for the poor. A same size land plot was allocated to each household at an affordable price. Since then, many residents moved in or out without registration, and the community expanded with sprawling shantytown outside the original boundary. Although the original residents were equally poor, some of the current residents are relatively well-off by buying up several plots to build brick houses, while others remain very poor sharing shanties made of bamboo and tin.

We defined the target population of this study as adults between 18 and 64 years of age who lived within the original boundary of Bauniabadh. Since accurate census data were not available, we conducted a census-like baseline survey targeting all households within the original boundary between August and November, 2014. We found that there were 8604 households with 34 170 residents, among whom 21 050 were adults between 18 and 64 years of age. The details of the baseline survey were described elsewhere [Khalequzzaman M, et al. manuscript under submission].

Sampling

We applied stratified random sampling according to gender and household wealth levels. We categorized household wealth levels into two groups: "lower-middle wealth" households were defined as those living in single- or multi-storied houses with concrete roofs, concrete floors, and brick walls; and "low wealth" households were defined as those living in houses with tin roofs, mud or wooden floors, and brick, thatch, or bamboo walls. Lower-middle wealth households usually have their own kitchens and toilets, while several low wealth households share a kitchen and a toilet. The baseline study data showed that 39% of the population in the community belonged to the lower-middle wealth group, while 61% belonged to the low wealth group.

Taking into account of statistical significance and study feasibility, we targeted at least 2000 subjects in total, or 500 subjects in each of the four strata: men and women in the lower-middle wealth and low wealth groups. We randomly assigned 1000 households for men and 1000 households for women in each wealth group. In total, 4000 households were selected, considering the possibilities that an eligible person may be unavailable in the assigned household or decline participation. We recruited an adult aged 18-64 years from each selected household by using Kish grid [13]. Pregnant women were excluded. If there was no eligible person, the household was excluded.

Staff training and community mobilization

Four men and two women who completed colleges and had experience of field studies were recruited as interviewers, and trained for five days on interview skills. Two supervisors managed field activities and controlled data quality. Nurses and laboratory technicians of National Heart Foundation Hospital and Research Institute were trained to conduct the standard physical measurements following WHO guidelines.

For encouraging people to participate in the survey, meetings with community leaders and other representatives were held in the community several times before and during the survey period. Community leaders were actively involved in motivating people to participate. Community women who worked as surveyors of the baseline study were assigned as community mobilizers and provided counseling for the selected persons.

Data collection

The field epidemiological study was conducted from October 2015 to April 2016, mostly following the standard WHO STEPS procedures [6]. We used a modified questionnaire of 2010 Bangladesh STEPS [8] which consisted of all core questions and some expanded questions in the WHO prototype and additional questions such as types of tobacco. We also incorporated the findings of qualitative studies conducted between November 2014 and August 2015 [14] and added several questions such as those related to salt intakes. The questionnaire was pretested in adjacent shantytowns and revised several times until all interviewers would be able to confidently complete the interview.

The interviewers visited the selected household and interviewed the eligible person in Bengali language. Participants who completed the interview were invited to a study clinic in the National Heart Foundation Hospital and Research Institute for physical measurements and blood sampling. The Institute was close to the community and transport costs were provided when the participants showed up. Those who failed to show up were reminded and motivated by the community mobilizers.

Participants were asked about medical histories and medications, then height, weight, waist and hip circumferences, and blood pressure were measured. The anthropometric measurements were taken in light clothing without shoes or other heavy accessories. After resting 15 minutes, blood pressure was measured three times in the upper arm by using automatic digital sphygmomanometer (HEM-8712, OMRON Corporation, Japan). Systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse per minute were recorded, and the arithmetic mean of the second and third readings of blood pressure was used for the analysis. In case of arrhythmia, blood pressure was measured twice by manual sphygmomanometer.

The poor people, who worked very early in the morning, could come to the study clinic only in the afternoon. Thus, random blood samples were taken to measure glucose, glycated hemoglobin (HbA1c), total, HDL- and LDL-cholesterol, triglycerides, and complete blood count. About 10 ml of venous blood was sampled and analyzed at the clinical laboratory of National Heart Foundation Hospital and Research Institute, using automatic analyzers (Dimension RxL Max, Siemens, USA, for glucose, total, HDL- and LDL-cholesterol, and triglycerides; and Hematology Analyzer Mythic 22, Orphee, Switzerland, for HbA1c, hemoglobin, red blood cell, white blood cell and platelet counts). For quality control and verification of the blood biochemical measurements, 5% of the samples were also tested by the clinical laboratories of Bangabandhu Sheikh Mujib Medical University and Bangladesh Institute of Health Sciences, an affiliation of Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders. The results of the three laboratories were consistent.

Data analysis

The participants' names are separated from the original sheets, which are coded with serial numbers. The anonymized data were inputted into a programmed data entry template and the accuracy of the data entry was verified using 10% double-entry method.

We categorized all continuous readings of physical and biochemical measurements according to well-defined standards. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, and then categorized into four groups: <18.5, 18.5–24.9, 25–29.9, and ≥30 kg/m^2 [15]. Hypertension was defined as SBP ≥140, DBP ≥90 mmHg, or use of antihypertensive medication [16]. Random blood glucose levels were classified as: <140, 140-199, and ≥200 mg/dL; and HbA1c levels as: <5.7, 5.7–6.4, and

≥6.5% [17]. Blood lipid levels were classified by the following cutoffs: total cholesterol levels as <200, 200-239, ≥240 mg/dL; HDL-cholesterol levels as <40, ≥60 mg/dL; LDL-cholesterol levels as <100, 100–129, 130–159, ≥160 mg/dL; triglyceride levels as <150, 150–199 and ≥200 mg/dL [18].

To test differences between men and women on each categorical data, chi-squared test was applied. Student's t-test was used for testing difference of mean age across gender. All of the statistical analyses were performed using the statistical software, IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY, USA).

Ethical considerations

This study was approved by the Bioethics Review Committee of Nagoya University School of Medicine, Japan (approval no. 2014-0021). Institutional Review Boards of Bangabandhu Sheikh Mujib Medical University and National Heart Foundation Hospital and Research Institute, Bangladesh, approved the study as well. Written informed consents were obtained from all participants.

RESULTS

In total, 2551 eligible persons participated in the questionnaire based interview: 1289 (674 men and 615 women) were from the lower-middle wealth group and 1262 (684 men and 578 women) were from the low wealth group. Among the interview participants, 2009 persons participated in the physical measurements and blood tests, of whom 1002 (504 men and 498 women) were from the lower-middle wealth group and 1007 (504 men and 503 women) were from the low wealth group.

Table 1 shows demographic and behavioral characteristics. Mean age of the 2551 participants was 35.5 years. About 60% of men and 22% of women were current tobacco users, but cigarette smoking was only reported from men (52.3%). Smokeless tobacco chewing were more common in women (21.7%) than men (15.5%). About 4% of men drank alcohol.

Most of them (92%) consumed at least 1 serving of fruit and vegetables per day, however, only 2% had more than 5 servings. Around 80% of the participants indicated that they added table salt to their meals. Prevalence of moderate or high level of total physical activity (>600 MET-minutes per week) was 75.3% in men and 31.9% in women.

Comparing to the lower-middle wealth group, the low wealth group participants were less likely to: be educated, be employed, have fruits and vegetable; and add salt. They were more likely to: be day laborers; use tobacco; and do physical activities.

Table 2 shows the percentages of biological indicators classified by appropriate criteria. Overweight/obesity was more common in women (39.3%) than men (19.4%), while underweight was more common in men (20.5%) than women (7.1%). Overweight/obesity prevalence were higher than the estimated national prevalence of men (16.4%) and women (24.2%) [19]. As shown in Table 3, the highest mean BMIs were observed in men and women aged 35-44 years.

According to WHO recommended cut-off points [20], prevalence of increased waist circumference (men >94 cm; women >80 cm) and increased waist-hip ratio (men ≥0.90; women ≥0.85) were 9.2% and 64.0% in men and 53.2% and 80.2% in women, respectively. Prevalence of increased waist circumference in men was 16.2%, according to the cut-off point for south Asian men (>90 cm) recommended by International Diabetes Federation [20].

The prevalence of hypertension was 18.6% in men and 20.6% in women, consistent with findings of previous STEPS surveys [9-11].

Prevalence of diabetes (HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment) was 15.3% in men and 22.2% in women, much higher than the WHO estimated national prevalence (men 8.6%; women 7.4%) [19]. Only 4.3% of men and 5.4% of women showed diabetes level of random blood glucose, indicating unreliability of random blood glucose for screening diabetes.

Mean value of total cholesterol was 166.6 mg/dL in men and 174.0 mg/dL in women, and mean value of HDL-cholesterol was as low as 34.3 mg/dL in men and 39.7 mg/dL in women. The prevalence of raised total cholesterol was 34.4% in women and 25.5% in men, respectively. High risk range of low HDL-cholesterol level (<40 mg/dL) was 73.3% in men and 56.0% in women, and borderline-high/high level LDL-cholesterol (≥130 mg/dL) was 11.6% in men and 12.8% in women. High level of triglycerides (≥200 mg/dL) was more common in men (31.9%) than women (22.4%).

Comparing to the lower-middle wealth group, BMI of the low wealth group men tended to be lower, but waist-hip ratio of them to be higher. Diabetes prevalence was higher in the low wealth group than in the lower-middle wealth group, and anemia prevalence was higher in the low wealth women than the lower-middle wealth women. There was not much difference between the two wealth groups regarding hypertension and blood lipids.

DISCUSSION

This study first comprehensively surveyed prevalence of various NCD risk factors, including blood lipid profile and HbA1c, among the urban poor in Bangladesh, who were considered to be underserved high risk population.

We revealed that overweight/obesity prevalence of both men and women was higher than the estimated national prevalence. Overweight/obesity prevalence in women was as high as 40%, which could be attributed to the sedentary lifestyle of urban women [21]. The characteristics of the urban poor in Bangladesh was that overweight/obesity and underweight were equally prevalent in men, reflecting their socio-economic situation: many men still had to be involved in hard physical labor [22], while some men could afford to eat well. Our findings suggested that both overweight/obesity and underweight should be paid attention simultaneously.

High prevalence of increased waist-hip ratio in both men and women and increased waist circumference in women indicated high risks of metabolic syndrome among the urban poor. However, it would require further studies to identify appropriate cut-off points and clinical implications of BMI, waist circumference, and waist-hip ratio in Bangladesh, considering the discrepancy between waist circumference and waist-hip ratio in men.

Our findings showed prevalence of diabetes was much higher than the WHO estimated national prevalence [19] and the findings of the 2006 STEPS survey (men 7.6%; women 2.8%) [10]. The prevalence of our study was in line with the increasing trend [19], therefore, diabetes prevalence may have increased since the last surveys. Diabetes prevalence of the poor may be higher than the national average, as shown in studies in high income countries indicating association of low socio-economic status and increased diabetes prevalence [23, 24]. Our study also showed that diabetes prevalence was higher in the low wealth group than in the lower-middle wealth group. This may attribute to childhood undernutrition in the low wealth group, but requires further investigation.

Diabetes prevalence was higher in women than men, contrary to the findings of the 2006 survey. The urban poor women may be more diabetic than men, since gender difference in diabetes prevalence may vary depending on socio-economic situations [25]. However, higher HbA1c level in women than men might have been due to higher prevalence of anemia (hemoglobin <11 mg/dL) [26] in women (14.6%) than men (1.8%), which was reported to shift HbA1c values toward higher ones [27-30]. In our study, we used the WHO recommended HbA1c cut-off point [31], but caution is needed in light of the high anemia prevalence. Further studies are required to interpret HbA1c value in low and lower-middle income countries.

Our study is the first population-based survey of blood lipid profile in Bangladesh. High risk range of low HDL-cholesterol was highly prevalent, but desirable range of low total cholesterol and LDL-cholesterol were both highly prevalent as well. Clinical implications of low levels of HDL- and LDL-cholesterol of this population need to be investigated further. Relatively high prevalence of high level of triglycerides might be overestimated, as random blood samples were used.

High prevalence of tobacco use was confirmed in this study, in consistent with previous studies [32, 33]. Chewing tobacco products seemed to be culturally tolerated, as shown that women often chewed tobacco but refrained smoking cigarettes. Different approaches for men and women need to be developed for controlling tobacco.

The strength of this study was that we targeted the urban poor, the underserved high risk population, using representative sampling methods. Analyzing blood samples by comprehensive automatic equipment in a reliable clinical laboratory, but not by portable device often used for STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as measurement of HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count. However, this study has several limitations. First, we targeted only one urban poor community, which may not represent nationwide situation. Second, targeting poor people, we could not measure fasting blood samples. While random blood glucose value was unreliable for screening diabetes, we found measuring HbA1c could be useful alternative.

In conclusion, the current survey revealed high prevalence of NCD risk factors among the urban poor in Bangladesh. Diabetes, hypertension, tobacco use, and both overweight and underweight were prevalent, indicating the dual burden among the urban poor. Our findings can serve as a baseline epidemiological data and help policymakers develop appropriate NCD control strategies.

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Contributors A.A., M.K., S.R.C., H.Y., and A.M. designed the study, M.K., S.R.C., M.A.A., B.A.H. and S.S.I. conducted the field survey and data collection, C.C., M.K., H.Y., S.R.C., and A.A. statistically analyzed and interpreted the data, A.A., M.K., C.C., and A.A.A.A. drafted the manuscript, H.Y., S.R.C., H.I., S.S.I., A.M., and Y.H. provided critical inputs on the draft. All authors approved the final draft.

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Competing interests None declared.

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Table 1. Demographic and behavioral characteristics of participants by gender and household wealth level (valid %)

	Men			Women			*p* for gender difference[a]
Household wealth level	Lower middle	Low	All	Lower middle	Low	All	
Number (n = 2551)	674	684	1358	615	578	1193	
Age group of years (%)							0.986
18-24	19.4	14.9	17.2	17.7	16.1	16.9	
25-34	35.0	32.9	33.9	37.1	31.0	34.1	
35-44	26.6	25.6	26.1	24.7	28.9	26.7	
45-54	13.9	15.9	14.9	13.7	14.9	14.2	
55-64	5.0	10.7	7.9	6.8	9.2	8.0	
Mean, years (95% CI)	35.57 (34.98 - 36.17)			35.33 (34.69 - 35.97)			0.586
Years of education (%)							<0.001
none	22.0	32.6	27.3	31.5	45.0	38.1	
1-4	10.5	17.4	14.0	15.9	23.0	19.4	
5-7	24.5	19.6	22.0	29.6	18.3	24.1	
8-9	20.7	16.5	18.6	13.2	8.5	10.9	
≥10	22.3	13.9	18.1	9.8	5.2	7.5	
Religion (%)							0.406
Islam	98.7	96.3	97.5	98.9	97.1	98.0	
Hinduism	1.3	3.7	2.5	1.1	2.9	2.0	
Marital status (%)							<0.001
unmarried	15.4	13.6	14.5	0.7	1.4	1.0	
married	84.6	85.8	85.2	90.2	85.3	87.8	
others	0.0	0.6	0.3	9.1	13.3	11.1	
Occupation (%)							<0.001
employed	22.8	13.6	18.2	17.4	14.0	15.8	
self-employed	44.2	43.1	43.7	3.6	13.3	8.3	
day labor	23.7	30.0	26.9	2.0	7.1	4.4	
homemaker	0.3	0.1	0.2	75.8	64.4	70.2	
others	8.9	13.2	11.0	1.3	1.2	1.3	
Cigarette smoking (%)							<0.001
non-smoker	43.6	38.7	41.2	99.5	98.1	98.8	
ex-smoker	7.7	5.4	6.6	0.5	1.9	1.2	
current smoker	48.7	55.8	52.3	0.0	0.0	0.0	
Smokeless tobacco chewing (%)							<0.001
non-user	87.8	78.4	83.1	84.6	68.9	76.9	
ex-user	0.6	2.3	1.5	0.7	2.1	1.3	
current user	11.6	19.3	15.5	14.8	29.1	21.7	
Tobacco product use (%)							<0.001
non-user	39.3	30.8	35.1	84.2	68.2	76.4	
ex-user	6.1	5.0	5.5	1.0	2.8	1.8	
current user	54.6	64.2	59.4	14.8	29.1	21.7	

Alcohol drinking (%)							<0.001
non-drinker	95.4	97.7	96.5	100.0	100.0	100.0	
current drinker	4.6	2.3	3.5	0.0	0.0	0.0	
Fruit/vegetable intake, servings per day (%)							<0.001
<1	7.3	6.9	7.1	3.3	16.5	9.7	
1-2.9	61.7	67.1	64.4	57.2	72.6	64.7	
3-4.9	31.0	24.5	27.7	31.7	10.6	21.4	
≥5	0.0	1.5	0.7	7.8	0.3	4.2	
Adding salt at the table (%)							0.001
always	70.2	46.6	58.3	67.0	41.0	54.4	
often	5.9	13.3	9.6	1.6	28.5	14.7	
sometimes	5.8	17.4	11.6	10.7	9.2	10.0	
never	18.1	22.7	20.4	20.7	21.3	21.0	
Total physical activity, MET-minutes per week (%)							
<600	30.4	19.0	24.7	83.9	51.4	68.1	<0.001
600-2999	38.3	26.9	32.5	14.8	44.5	29.2	
≥3000	31.3	54.1	42.8	1.3	4.2	2.7	

Abbreviation: CI, confidence interval; MET, metabolic equivalent

[a] Gender differences between all men and all women were tested by chi-squared test and t-test as appropriate.

Table 2. Physical and biochemical characteristics of participants by gender and household wealth level (valid %)

Household wealth level	Men			Women			p for gender difference[a]
	Lower middle	Low	All	Lower middle	Low	All	
Number (n = 2009)	504	504	1008	498	503	1001	
Body mass index, kg/m^2 (%)							<0.001
<18.5	18.5	22.6	20.5	7.2	7.0	7.1	
18.5-24.9	60.3	59.9	60.1	53.4	53.9	53.6	
25-29.9	19.2	15.9	17.6	30.9	29.4	30.2	
≥30	2.0	1.6	1.8	8.4	9.7	9.1	
Waist circumference, cm (%)							0.001
≤80	53.8	56.2	55.0	47.0	46.5	46.8	
81-90	29.6	28.0	28.8	29.5	34.2	31.9	
91-94	7.5	6.5	7.0	9.0	7.8	8.4	
>94	9.1	9.3	9.2	14.5	11.5	13.0	
Waist-hip ratio (%)							<0.001
<0.8	2.6	4.2	3.4	5.4	5.8	5.6	
0.8-0.84	11.3	9.5	10.4	13.9	14.5	14.2	
0.85-0.89	24.0	20.4	22.2	22.9	27.5	25.2	
≥0.9	62.1	65.9	64.0	57.8	52.2	55.0	
Systolic blood pressure, mmHg (%)							<0.001
<120	55.6	56.9	56.3	67.9	65.4	66.6	
120-129	23.2	18.5	20.8	14.7	14.9	14.8	
130-139	10.7	11.9	11.3	7.8	8.2	8.0	
≥140	10.5	12.7	11.6	9.6	11.5	10.6	
Diastolic blood pressure, mmHg (%)							0.587
<80	58.9	59.7	59.3	60.6	63.2	61.9	
80-84	15.9	14.1	15.0	14.1	13.1	13.6	
85-89	11.5	11.5	11.5	10.0	10.5	10.3	
≥90	13.7	14.7	14.2	15.3	13.1	14.2	
Hypertension (%)							
≥140/90 mmHg	16.9	18.1	17.5	16.5	16.7	16.6	0.601
≥140/90 mmHg or on medication	18.3	18.8	18.6	20.3	20.9	20.6	0.252
Random blood glucose, mg/dL (%)							0.204
<140	93.3	91.3	92.3	89.2	90.9	90.0	
140-199	3.6	3.4	3.5	5.6	3.6	4.6	
≥200	3.2	5.4	4.3	5.2	5.6	5.4	
HbA1c, % (%)							0.001
<5.7	51.4	48.8	50.1	49.6	46.3	48.0	
5.7-6.4	35.1	34.5	34.8	31.1	30.6	30.9	
≥6.5	13.5	16.7	15.1	19.3	23.1	21.2	
Diabetes[b] (%)	13.7	16.9	15.3	20.7	23.7	22.2	<0.001

Triglycerides, mg/dL (%)							<0.001
<100	24.6	30.2	27.4	36.7	36.0	36.4	
100-149	25.0	22.8	23.9	25.5	24.7	25.1	
150-199	19.4	14.1	16.8	15.5	16.9	16.2	
≥200	31.0	32.9	31.9	22.3	22.5	22.4	
Total cholesterol, mg/dL (%)							<0.001
<150	36.1	36.5	36.3	27.7	30.2	29.0	
150-189	40.1	37.7	38.9	37.1	38.2	37.7	
190-199	4.4	6.9	5.7	8.6	8.3	8.5	
200-239	15.1	14.7	14.9	19.9	17.7	18.8	
≥240	4.4	4.2	4.3	6.6	5.6	6.1	
(≥190mg/dL or on medication)	24.4	26.6	25.5	35.9	32.8	34.4	<0.001
HDL-cholesterol, mg/dL (%)							<0.001
<40	73.8	72.8	73.3	57.1	54.9	56.0	
40-49	20.4	19.2	19.8	27.2	27.4	27.3	
≥50	5.8	7.9	6.8	15.7	17.7	16.7	
LDL-cholesterol, mg/dL (%)							0.805
<100	54.3	58.3	56.3	51.4	57.4	54.4	
100-129	34.2	30.0	31.1	34.5	31.1	32.8	
130-159	9.5	9.3	9.4	11.0	9.8	10.4	
≥160	2.0	2.4	2.2	3.0	1.8	2.4	
Hemoglobin, mg/dL (%)							<0.001
<11	1.6	2.0	1.8	13.9	15.3	14.6	
11-11.9	3.6	3.6	3.6	25.3	29.0	27.2	
12-12.9	6.2	9.5	7.8	39.0	33.2	36.1	
13-16.9	88.1	84.1	86.1	21.9	22.5	22.2	
≥17	0.6	0.8	0.7	0.0	0.0	0.0	

Abbreviation: HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Gender differences between all men and all women were tested by chi-squared test.

[b] Defined as random blood glucose ≥200 mg/dL or HbA1c ≥6.5% or on diabetes treatment.

Table 3. Mean of physical and biochemical measurements by gender and age group

	Men						Women					
Age group, year	18-24	25-34	35-44	45-54	55-64	All	18-24	25-34	35-44	45-54	55-64	All
Number (n = 2009)	176	331	254	163	84	1008	148	329	276	155	93	1001
Body mass index, kg/m^2	20.16	21.71	22.78	22.18	21.44	21.76	22.20	24.32	25.08	24.36	23.58	24.15
Waist circumference, cm	73.22	78.81	82.93	82.92	82.89	79.88	75.89	80.96	84.20	84.88	84.81	82.07
Waist-hip ratio	0.865	0.911	0.944	0.963	0.967	0.925	0.871	0.896	0.911	0.932	0.951	0.907
Systolic blood pressure, mmHg	116.29	117.50	120.13	123.94	133.96	120.36	106.20	109.66	118.57	122.30	133.01	115.73
Diastolic blood pressure, mmHg	72.95	76.94	80.01	81.81	84.06	78.40	71.33	75.89	80.59	80.72	83.39	77.96
Random blood glucose, mg/dL	91.09	99.83	113.81	119.03	119.69	106.59	91.72	102.63	106.61	127.46	138.95	109.33
HbA1c, %	5.44	5.70	6.07	6.23	6.19	5.87	5.51	5.83	5.97	6.49	6.91	6.02
Hemoglobin, mg/dL	14.48	14.49	14.36	13.72	13.18	14.22	12.29	12.25	11.97	11.79	11.61	12.05
Triglycerides, mg/dL	129.80	194.40	196.45	198.44	182.95	183.34	105.22	130.04	154.75	199.84	217.29	152.09
Total cholesterol, mg/dL	145.19	166.59	174.15	172.62	175.77	166.50	157.41	166.83	175.13	189.91	197.68	174.16
HDL-cholesterol, mg/dL	34.78	34.37	33.85	33.17	36.38	34.28	41.42	39.32	39.09	40.02	39.09	39.65
LDL-cholesterol, mg/dL	86.21	96.91	100.98	99.90	99.69	96.78	88.69	95.88	101.49	106.05	107.26	98.99

Abbreviation: HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

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Non-communicable disease risk factors among the poor living in a shantytown in Dhaka city, Bangladesh

Md. Khalequzzaman[1], Chifa Chiang[2], Sohel Reza Choudhury[3], Hiroshi Yatsuya[2, 4], Mohammad Abdullah Al-Mamun[3], Abubakr Ahmed Abdullah Al-Shoaibi[2], Yoshihisa Hirakawa[2], Bilqis Amin Hoque[5], Syed Shariful Islam[1], Akiko Matsuyama[6], Hiroyasu Iso[7], and Atsuko Aoyama[2*]

[1] Department of Public Health and Informatics, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

[2] Department of Public Health and Health Systems, Nagoya University School of Medicine, Nagoya, Japan

[3] Department of Epidemiology and Research, National Heart Foundation Hospital and Research Institute, Dhaka, Bangladesh

[4] Department of Public Health, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

[5] Environment and Population Research Center, Dhaka, Bangladesh

[6] Nagasaki University School of Tropical Medicine and Global Health, Nagasaki, Japan

[7] Public Health Graduate School of Medicine, Osaka University, Suita, Osaka, Japan

*Corresponding author: Atsuko Aoyama, MD, PhD

Department of Public Health and Health Systems, Nagoya University School of Medicine

65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan

e-mail: atsukoa@med.nagoya-u.ac.jp

telephone: +81-52-744-2108

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ABSTRACT

Objectives: This study aims to describe non-communicable disease (NCD) risk factor prevalence of the urban poor in Bangladesh.

Design: We conducted a community based cross-sectional epidemiological study.

Setting: The study was conducted in a shantytown in Dhaka city. There were 21 050 adults aged 18 to 64 years living in 8604 households. Those households were categorized into two wealth strata based on the housing structure.

Participants: The study targeted 18-64 year old residents. A total of 2986 eligible households with one eligible individual were selected by random sampling stratified by household wealth status. A total of 2551 residents completed the questionnaire survey, and 2009 participated in the subsequent physical and biochemical measurements.

Outcome measures: A modified WHO STEPS instrument was used for assessing behavioral risk factors and physical and biochemical measurements including glycated hemoglobin (HbA1c). Simple unweighted prevalence of NCD risk factors, such as tobacco use, fruits and vegetable intake, overweight/obesity, hypertension, diabetes (HbA1c ≥6.5%), and dyslipidemia was described and their difference by gender and household wealth status was analyzed.

Results: Prevalence of current tobacco users was 59.4% in men and 21.7% in women. Most of them (91.6%) consumed more than 1 serving of fruits and vegetables per day, however, only 2.5% had more than 5 servings. Overweight/obesity was more common in women (39.3%) than in men (19.4%), while underweight was more common in men (20.5%) than in women (7.1%). Prevalence of hypertension was 18.6% in men and 20.6% in women. Prevalence of diabetes was 15.3% in men and 22.2% in women, much higher than the estimated national prevalence (7%). The prevalence of raised total cholesterol was 25.5% in men and 34.4% in women, respectively.

Conclusions: The study identified tobacco use, both overweight and underweight, diabetes, hypertension, and dyslipidemia were prevalent among the urban poor in Bangladesh.

Strengths and limitations of this study:

- This study is the first population based survey including measurement of glycated hemoglobin (HbA1c) and blood lipid profile in an urban setting of Bangladesh.
- This study targeted the urban poor, the underserved high risk population, using representative sampling methods.
- Analyzing blood samples by high-performance automatic equipment in a reliable clinical laboratory, but not by portable device often used for STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count.
- This study targeted only one urban poor community, which may not represent nationwide situation.
- We could not measure fasting blood samples, but used HbA1c as a useful alternative.
- The results of this study were obtained from a simple unweighted analysis, and they might reflect the attributes of the selected participants in the study.

INTRODUCTION

Non-communicable diseases (NCDs) are globally recognized threats, thus reducing the burden of NCDs has been included as one of the targets of the Sustainable Development Goals [1]. NCDs are new priorities and additional burdens on health in low and middle income countries, where urbanization and lifestyle changes are advancing rapidly. In addition, low birth weight and childhood malnutrition among the poor may increase the risks of cardiovascular diseases and diabetes in adulthood [2, 3].

Bangladesh is a lower-middle income country in South Asia, with over 160 million population in 2015 [4]. While infectious diseases are still prevalent, the burden of NCDs is also increasing even among the poor [5]. Population-based NCD risk factor surveys by a standardized method of the World Health Organization (WHO), *i.e.* STEPwise approach to surveillance (STEPS) [6], had been conducted four times in the past in Bangladesh [7-11]. The WHO STEPS approach is a simple, standardized and flexible method which can be implemented in any countries for monitoring NCD risk factors, and allows comparison across countries. The STEPS instrument includes: Step 1, questionnaire-based assessment of behavioral risk factors, such as tobacco use, alcohol consumption, diet and physical activity; Step 2, physical measurements of weight, height, waist and hip circumferences, and blood pressure; and Step 3, biochemical measurements of fasting blood glucose and blood lipids such as total cholesterol. The STEPS surveys of 2002, 2010, and 2013 implemented only Step 1 and 2. Measurement of blood glucose and total cholesterol, or Step 3 was conducted only in the 2006 survey. The 2013 STEPS reported prevalence of overweight/obesity as 25.7% (urban 29%, rural 23%), hypertension as 21.4% (urban 27%, rural 18%), and tobacco use as 43.9% (urban 45%, rural 43%) [9]. The STEPS 2006 reported prevalence of diabetes as 5.5% and raised total cholesterol as 6.9% [10]. Another population-based survey on blood lipid profile including high-density lipoprotein (HDL)-cholesterol, low-density lipoprotein

(LDL)-cholesterol and triglycerides was conducted in 2001, targeting less than 500 rural residents [12].

Urban population in Bangladesh is rapidly increasing, as indicated by 3.4% annual urban population growth in comparison with 1.2% in the whole nation [4]. Along with the population growth of the urban poor, the burden of NCDs is increasing, due to the lifestyle changes and possible childhood undernutrition. However, the situation of NCDs and their risk factors among the urban poor has not been known yet, and data and information on prevalence of NCD risk factors are mostly unavailable.

We conducted a cross-sectional epidemiological study on NCD risk factors applying a modified WHO STEPS procedure, and a qualitative study on perception and attitude towards NCD risk factors among the people in a poor community in Dhaka city, Bangladesh. This paper aims to describe the epidemiological profile of NCD risk factors among the urban poor in Dhaka city, Bangladesh.

METHODS

Study site and study population

We conducted the study in Bauniabadh, an urban poor community in Dhaka city, Bangladesh [13]. The community was originally established by the government in 1972 as a settlement for the poor. An equal size land plot was allocated to each household at an affordable price. Since then, many residents moved in or out without registration, and the community expanded with sprawling shantytown outside the original boundary. Although the original residents were equally poor, some of the current residents are relatively well-off by buying up several plots to build brick houses, while others remain very poor sharing shanties made of bamboo and tin.

We defined the target population of this study as adults between 18 and 64 years of age

who lived within the original boundary of Bauniabadh. Since accurate census data were not available, we conducted a census-like baseline survey targeting all households within the original boundary between August and November, 2014. Persons or family members who made common provision of food and resided under the same roof were regarded as the members of the same household. We identified 8604 households with 34 170 residents, among whom

21 050 were adults between 18 and 64 years of age. The details of the baseline survey were described elsewhere [14].

While all dwellers of the shantytown were recognized as the urban poor, the findings of the baseline survey indicated that household wealth status somewhat varied among them. We categorized household wealth status into two groups: "housing level 1" households were defined as those living in single- or multi-storied houses with concrete roofs, concrete floors, and brick walls; and "housing level 2" households were defined as those living in houses with tin roofs, mud or wooden floors, and brick, thatch, or bamboo walls. Housing level 1 households usually have their own kitchens and toilets, while several housing level 2 households share a kitchen and a toilet. The baseline survey data showed that 39% of the population in the community belonged to the housing level 1 group, while 61% belonged to the housing level 2 group. There was no difference in the proportion of gender in each group.

Sampling

We applied stratified random sampling according to gender and the housing wealth status. Taking into account of statistical significance and study feasibility, we targeted to recruit at least 2000 subjects in total, or 500 subjects in each of the four strata: men and women in the housing level 1 and the housing level 2 groups. To achieve the target, we randomly selected 1000 households for men and 1000 households for women in each housing level group at the outset of the study. In total, 4000 households were selected, considering the possibilities that an eligible person may be unavailable in the assigned household or decline participation. We recruited one adult aged 18-64 years from each selected household by using Kish grid [15], until the total recruited subjects in each strata surpassed 500. Pregnant women were excluded. We stopped recruiting after visiting 3560 selected households. Among the 3560 selected households, 576 households were found ineligible due to absence of any eligible persons. Out of 2986 eligible households with one eligible person, 435 selected persons declined or were unavailable. Finally, 2551 subjects completed the interview conducted at their home (interview response rate: 85.4%) and 2009 subjects came to a study clinic in the National Heart Foundation Hospital and Research Institute (NHFH&RI) to complete physical and biochemical measurements (response rate: 67.3%).

Staff training and community mobilization

Four men and two women who completed college education and had experience of field studies were recruited as interviewers, and trained for five days on interview skills. Two supervisors managed field activities and monitored data quality. Nurses and laboratory technicians of NHFH&RI were trained to conduct the standard physical measurements following WHO guidelines.

For encouraging people to participate in the survey, meetings with community leaders and other representatives were held in the community several times before and during the survey period. Community leaders were actively involved in motivating people to participate. Community women who worked as surveyors of our previous baseline study were assigned as community mobilizers and provided counseling for the selected persons.

Data collection

The field epidemiological study was conducted from October 2015 to April 2016, mostly following the standard WHO STEPS procedures [6]. We used a modified questionnaire of 2010 Bangladesh STEPS [8] which consisted of all core questions and some expanded questions in the WHO prototype and additional questions such as types of tobacco. We also incorporated the findings of qualitative studies conducted between November 2014 and August 2015 [16] and added several questions such as those related to salt intakes. The questionnaire was pretested in adjacent shantytowns and revised several times until all interviewers became confident in completing the interviews.

The interviewers visited the selected household and interviewed the eligible person in Bengali language. Participants who completed the interview were invited to the study clinic in NHFH&RI for physical measurements and blood sampling. The Institute was close to the community and transport cost was provided when a participant showed up. Those who failed to show up were reminded and motivated by the community mobilizers.

Participants were asked about medical histories and medications, then height, weight, waist and hip circumferences, and blood pressure were measured. Female nurses conducted the anthropometric measurement of women participants. The anthropometric measurements were taken in light clothing without shoes or other heavy accessories. After resting 15 minutes, blood pressure was measured three times in the right upper arm by using automatic digital sphygmomanometer (HEM-8712, OMRON Corporation, Japan). Systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse per minute were recorded, and the arithmetic mean of the second and third readings of blood pressure was used for the analysis. In case of arrhythmia, blood pressure was measured twice by manual sphygmomanometer.

The poor people, who worked very early in the morning, could come to the study clinic only in the afternoon. Thus, random blood samples were taken to measure glucose, glycated hemoglobin (HbA1c), total, HDL- and LDL-cholesterol, triglycerides, and complete blood count. About 10 ml of venous blood was drawn and analyzed at the clinical laboratory of NHFH&RI, using automatic analyzers (Dimension RxL Max, Siemens, USA, for glucose, total, HDL- and LDL-cholesterol, triglycerides and HbA1c; and Hematology Analyzer Mythic 22, Orphee, Switzerland, for hemoglobin, red blood cell, white blood cell and platelet counts). For quality assurance, 5% split samples of serum total cholesterol were measured in the biochemistry laboratory of Bangabandhu Sheikh Mujib Medical University (BSMMU) and 2.5% spilt samples of HbA1c were measured in the biochemistry laboratory of Bangladesh University of Health Sciences (BUHS), an institution of Bangladesh Diabetic Association. In both cases, similar methods for measurements were used. Coefficient of variations (CVs) for total cholesterol measurement in NHFH&RI and BSMMU were 24.6% and 26.8% and CVs for HbA1c in NHFH&RI and BUHS were 11.4% and 11.6%. The differences between the CVs, tested by Levene's F test, were not significant for both total cholesterol and HbA1c measurements.

Data analysis

The participants' names were separated from the original sheets, which were coded with serial numbers. The anonymized data were entered in a programmed data entry template and the accuracy of the data entry was verified using 10% double-entry method. There were no missing variables in the present analyses except for one person's gender. We excluded the subject from the data analysis.

We categorized all continuous readings of physical and biochemical measurements according to well-defined standards. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, and then categorized into four groups: <18.5, 18.5–24.9, 25–29.9, and ≥30 kg/m^2 [17]. Hypertension was defined as SBP ≥140 mmHg, or DBP ≥90 mmHg, or use of any antihypertensive medication [18]. Random blood glucose levels were classified as: <140, 140-199, and ≥200 mg/dL; and HbA1c levels as: <5.7, 5.7–6.4, and ≥6.5% [19]. Blood lipid levels were classified by the following cutoff values: total cholesterol levels as <150, 150–189, 190–199, 200–239, ≥240 mg/dL; HDL-cholesterol levels as <40, 40–49, ≥50 mg/dL; LDL-cholesterol levels as <100, 100–129, 130–159, ≥160 mg/dL; triglyceride levels as <100, 100–149, 150–199 and ≥200 mg/dL [20, 21].

Simple unweighted prevalence was used in the present paper. To test differences between men and women on each categorical data, chi-squared test was applied. Student's t-test was used for testing difference of means across gender. For data with skewed distributions, Mann-Whitney U test was used to test the differences. All of the statistical analyses were performed using the statistical software, IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY, USA).

Ethical considerations

This study was approved by the Bioethics Review Committee of Nagoya University School of Medicine, Japan (approval no. 2014-0021). Institutional Review Boards of BSMMU and NHFH&RI, Bangladesh, approved the study as well. Written informed consents were obtained from all participants. Participants with no education provided fingerprints on the consent sheets after receiving sufficient verbal explanation.

RESULTS

In total, 2551 eligible persons participated in the questionnaire-based interview: 1289 (674 men and 615 women) were from the housing level 1 group and 1262 (684 men and 578 women) were from the housing level 2 group. Among the interview participants, 2009 persons (78.8%) participated in the physical and biochemical measurements, of whom 1002 (504 men and 498 women) were from the housing level 1 group and 1007 (504 men and 503 women) were from the housing level 2 group.

Table 1 shows demographic and behavioral characteristics. Mean age of the 2551 participants was 35.5 years. Current tobacco users were 59.4% of men (54.6% in the housing level 1 and 64.2% in the housing level 2) and 21.7% of women (14.8% in the housing level 1 and 29.1% in the housing level 2). Tobacco smoking (cigarette, *beedi*, *etc.*) was reported only from men (52.3% in total, 48.7% in the housing level 1 and 55.8% in the housing level 2). Smokeless tobacco chewing was more common in women (21.7% in total, 14.8% in the housing level 1 and 29.1% in the housing level 2) than men (15.5% in total, 11.6% in the housing level 1 and 19.3% in the housing level 2). Alcohol drinking was reported only from men (3.5% in total, 4.6% in the housing level 1 and 2.3% in the housing level 2).

Most of them (92.9% of men and 90.3% of women) consumed at least 1 serving of fruits and vegetables per day, however, those who had more than 5 servings were only 0.8% of men and 4.2% of women. Those who had less than 1 serving were 7.1% of men (7.3% in the housing level 1 and 6.9 % in the housing level 2) and 9.7% of women (3.3% in the housing level 1 and 16.5% in the housing level 2). Only 20.4% of men and 21.0% of women reported that they never added table salt to their meals, while 58.3% of men and 54.4% of women always took additional salt. Prevalence of moderate or high level of total physical activity (≥600 MET-minutes per week) was 75.3% in men and 31.9% in women, which is comparable with the findings of urban population of 2010 STEPS [22].

Comparing to the housing level 1 group, the housing level 2 group participants were less likely to: be educated, be employed, have fruits and vegetable; and add salt. They were more likely to be: day laborers; tobacco users; and physically active (*P* <0.05 for all, not shown in the Tables).

Table 2 shows the percentages of biological indicators classified by appropriate criteria, and Table 3 shows prevalence of biological NCD risk factors by gender and household wealth status. Overweight/obesity was more common in women (39.3%) than men (19.4%), while underweight was more common in men (20.5%) than women (7.1%). Overweight/obesity prevalence was higher than the estimated national prevalence of men (16.4%) and women (24.2%) [23].

According to WHO recommended cut-off points [24], prevalence of increased waist circumference (men >94 cm; women >80 cm) and increased waist-hip ratio (men ≥0.90; women ≥0.85) were 9.2% and 64.0% in men and 53.2% and 80.2% in women, respectively. Prevalence of increased waist circumference in men was 16.2%, according to the cut-off point for south Asian men (>90 cm) recommended by International Diabetes Federation [24].

The prevalence of hypertension was 18.6% in men and 20.6% in women, which was comparable with findings of previous STEPS surveys [9-11].

Prevalence of diabetes (HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment) [19] was 15.3% in men (13.7% in the housing level 1 and 16.9% in the housing level 2) and 22.2% in women (20.7% in the housing level 1 and 23.7% in the housing level 2), much higher than the WHO estimated national prevalence (men 8.6%; women 7.4%) [23]. Only 4.3% of men and 5.4% of women showed diabetes level of random blood glucose, indicating unreliability of random blood glucose for screening diabetes.

Mean value of total cholesterol was 166.5 mg/dL in men and 174.2 mg/dL in women, and median value of HDL-cholesterol was as low as 33 mg/dL in men and 38 mg/dL in women. The prevalence of raised total cholesterol (≥190mg/dL or on medication) was 25.5% in men and 34.4% in women, respectively. High risk range of low HDL-cholesterol level (<40 mg/dL) [20] was 73.3% in men and 56.0% in women, and borderline-high/high level LDL-cholesterol (≥130 mg/dL) [20] was 11.7% in men and 12.9% in women. High level of triglycerides (≥200 mg/dL) [20] was more common in men (31.9%) than women (22.4%).

Regarding the prevalence of physical and biochemical risk factors, such as overweight/obesity, hypertension, diabetes and dyslipidemia, significant difference was not found between the housing level 1 and the housing level 2 groups (not shown in Tables).

DISCUSSION

This study is the first comprehensive epidemiological survey of various NCD risk factors including HbA1c among the urban poor in Bangladesh, who are considered to be underserved high risk population.

We found that overweight/obesity prevalence of both men and women was higher than the estimated national prevalence. Overweight/obesity prevalence in women was as high as 40%, which could be attributed to the sedentary lifestyle of urban women [25]. The characteristics of the urban poor in Bangladesh was that overweight/obesity and underweight were equally prevalent in men, reflecting their socio-economic situation: many men still had to be involved in hard physical labor [26], while some men could afford to eat well. Our findings suggested that both overweight/obesity and underweight should be addressed simultaneously.

High prevalence of increased waist-hip ratio in both men and women and increased waist circumference in women indicated high risks of metabolic syndrome among the urban poor. However, it would require further studies to identify appropriate cut-off points and clinical implications of BMI, waist circumference, and waist-hip ratio in Bangladesh, considering the discrepancy between waist circumference and waist-hip ratio in men.

Although we used simple unweighted prevalence, our findings showed prevalence of diabetes was much higher than the WHO estimated national prevalence [23] and the findings of the 2006 STEPS survey (men 7.6%; women 2.8%) [10]. The findings of our study was in line with the increasing trend reported elsewhere [23], therefore, diabetes prevalence may have increased since the last surveys. Diabetes prevalence of the poor may be higher than the national average, as shown in studies in high income countries indicating an association of low socio-economic status and increased diabetes prevalence [27, 28]. The higher diabetes prevalence among the urban poor may be attributed to childhood undernutrition, but requires further investigation.

Diabetes prevalence was higher in women than men, contrary to the findings of the 2006 survey. The urban poor women may be more prone to diabetes than men, since gender difference in diabetes prevalence may vary depending on socio-economic situations [29]. However, higher HbA1c level in women than men might have been due to higher prevalence of anemia (hemoglobin <11 mg/dL) [30] in women (14.6%) than men (1.8%), which was reported to shift HbA1c values toward higher ends [31-34]. In our study, we used the WHO recommended HbA1c cut-off point [35], but caution is needed in light of the high anemia prevalence. Further studies are required to fully understand and interpret HbA1c value in low and lower-middle income countries.

Our study is the first population-based survey of blood lipid profile of the urban poor in Bangladesh. High risk range of low HDL-cholesterol was highly prevalent, but desirable range of low total cholesterol and LDL-cholesterol were both highly prevalent as well. The findings were consistent with the findings of a previous study of rural population, although desirable range of low LDL-cholesterol was more prevalent in our study than the previous one [12] Clinical implications of low levels of HDL- and LDL-cholesterol of this population need to be investigated further. Relatively high prevalence of high level of triglycerides might be overestimated, as random blood samples were used.

High prevalence of tobacco use was confirmed in this study. This is consistent with previous studies [36, 37]. Chewing tobacco products seemed to be culturally tolerated, as shown that women often chewed tobacco but refrained smoking tobacco. Different approaches for men and women need to be developed for controlling tobacco.

About 80% of participants added table salt to their meals, although the meals were cooked and seasoned with salt. Further studies are needed to determine the amount of salt intake of this population, as we did not measure total salt intake. Our qualitative study found that people in the community sprinkled table salt on rice because they liked salty taste and served salt with meal for welcoming guests [16]. While salt reduction is known to be a cost effective strategy to prevent cardiovascular diseases [38, 39], modifying dietary habit of individuals in short time would be very difficult. Thus, a long term community wide campaign to modify diet is required, as shown in successful examples in Japan [40, 41].

The strength of this study is that we targeted the urban poor, the underserved high risk population, using representative sampling methods. Analyzing blood samples by high-performance automatic equipment in a reliable clinical laboratory, but not by portable device often used by STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count. However, this study has several limitations. First, we targeted only one urban poor community, which may not represent nationwide situation. Second, we could not measure fasting blood samples. While random blood glucose value was unreliable for screening diabetes, we found measuring HbA1c could be a useful alternative. Third, simple unweighted prevalence was presented for the prevalence of total participants in the present analysis. However, we refrained from drawing conclusions using unweighted simple prevalence, and we depicted prevalence separately for housing level 1 and 2 when appropriate. Nevertheless, it should be noted that prevalence estimates presented for all participants, where the housing level 1 group (39% of total population) over-represented, might not represent the whole target population.

In conclusion, the current survey revealed high prevalence of NCD risk factors among the urban poor in Bangladesh. Diabetes, dyslipidemia, hypertension, tobacco use, and both overweight and underweight were prevalent, indicating the dual burden among the urban poor.

Our findings can serve as baseline epidemiological data and help policymakers develop appropriate NCD control strategies.

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Contributors A.A., M.K., S.R.C., H.Y., and A.M. designed the study, M.K., S.R.C., M.A.A., B.A.H. and S.S.I. conducted the field survey and data collection, C.C., M.K., H.Y., S.R.C., and A.A. statistically analyzed and interpreted the data, A.A., M.K., C.C., and A.A.A.A. drafted the manuscript, H.Y., S.R.C., H.I., S.S.I., A.M., and Y.H. provided critical inputs on the draft. All authors approved the final draft.

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Competing interests None declared.

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Table 1. Demographic and behavioral characteristics of participants by gender and household wealth status

Household wealth status	Men			Women			*p* for gender difference[a]
	Housing level 1	Housing level 2	All	Housing level 1	Housing level 2	All	
Number	674	684	1358	615	578	1193	
Age group of years (%)							0.986
18-24	19.4	14.9	17.2	17.7	16.1	16.9	
25-34	35.0	32.9	33.9	37.1	31.0	34.1	
35-44	26.6	25.6	26.1	24.7	28.9	26.7	
45-54	13.9	15.9	14.9	13.7	14.9	14.2	
55-64	5.0	10.7	7.9	6.8	9.2	8.0	
mean (95% CI)	35.57 (34.98 - 36.17)			35.33 (34.69 - 35.97)			0.586
Years of education (%)							<0.001
none	22.0	32.6	27.3	31.5	45.0	38.1	
1-4	10.5	17.4	14.0	15.9	23.0	19.4	
5-7	24.5	19.6	22.0	29.6	18.3	24.1	
8-9	20.7	16.5	18.6	13.2	8.5	10.9	
≥10	22.3	13.9	18.1	9.8	5.2	7.5	
Religion (%)							0.406
Islam	98.7	96.3	97.5	98.9	97.1	98.0	
Hinduism	1.3	3.7	2.5	1.1	2.9	2.0	
Marital status (%)							<0.001
unmarried	15.4	13.6	14.5	0.7	1.4	1.0	
married	84.6	85.8	85.2	90.2	85.3	87.8	
others	0.0	0.6	0.3	9.1	13.3	11.1	
Occupation (%)							<0.001
employed	22.8	13.6	18.2	17.4	14.0	15.8	
self-employed	44.2	43.1	43.7	3.6	13.3	8.3	
day labor	23.7	30.0	26.9	2.0	7.1	4.4	
homemaker	0.3	0.1	0.2	75.8	64.4	70.2	
others	8.9	13.2	11.0	1.3	1.2	1.3	
Any form of tobacco (%)							<0.001
non-user	39.3	30.8	35.1	84.2	68.2	76.4	
ex-user	6.1	5.0	5.5	1.0	2.8	1.8	
current user	54.6	64.2	59.4	14.8	29.1	21.7	
Tobacco smoking (%)							<0.001
non-smoker	43.6	38.7	41.2	99.5	98.1	98.8	
ex-smoker	7.7	5.4	6.6	0.5	1.9	1.2	

current smoker	48.7	55.8	52.3	0.0	0.0	0.0	
Smokeless tobacco chewing (%)							<0.001
non-user	87.8	78.4	83.1	84.6	68.9	76.9	
ex-user	0.6	2.3	1.5	0.7	2.1	1.3	
current user	11.6	19.3	15.5	14.8	29.1	21.7	
Alcohol drinking (%)							<0.001
non-drinker	95.4	97.7	96.5	100.0	100.0	100.0	
current drinker	4.6	2.3	3.5	0.0	0.0	0.0	
Fruit/vegetable intake, servings per day (%)							<0.001
<1	7.3	6.9	7.1	3.3	16.5	9.7	
1-2.9	61.7	67.1	64.4	57.2	72.6	64.7	
3-4.9	31.0	24.5	27.7	31.7	10.6	21.4	
≥5	0.0	1.5	0.8	7.8	0.3	4.2	
Adding salt at the table (%)							0.001
always	70.2	46.6	58.3	67.0	41.0	54.4	
often	5.9	13.3	9.6	1.6	28.5	14.7	
sometimes	5.8	17.4	11.6	10.7	9.2	10.0	
never	18.1	22.7	20.4	20.7	21.3	21.0	
Total physical activity, MET-minutes per week (%)							<0.001
<600	30.4	19.0	24.7	83.9	51.4	68.1	
600-2999	38.3	26.9	32.5	14.8	44.5	29.2	
≥3000	31.3	54.1	42.8	1.3	4.2	2.7	

Abbreviation: CI, confidence interval; MET, metabolic equivalent
[a] Gender differences between all men and all women were tested by chi-squared test and t-test as appropriate.

Table 2. Physical and biochemical characteristics of participants by gender and household wealth status

Household wealth status	Men			Women			*p* for gender difference
	Housing level 1	Housing level 2	All	Housing level 1	Housing level 2	All	
Number	504	504	1008	498	503	1001	
Body mass index, kg/m^2 (%)							<0.001[a]
<18.5	18.5	22.6	20.5	7.2	7.0	7.1	
18.5-24.9	60.3	59.9	60.1	53.4	53.9	53.6	
25-29.9	19.2	15.9	17.6	30.9	29.4	30.2	
≥30	2.0	1.6	1.8	8.4	9.7	9.1	
mean (95% CI)	21.76 (14.47 - 29.05)			24.15 (13.06 - 39.68)			<0.001[b]
Waist circumference, cm (%)							0.001[a]
≤80	53.8	56.2	55.0	47.0	46.5	46.8	
81-90	29.6	28.0	28.8	29.5	34.2	31.9	
91-94	7.5	6.5	7.0	9.0	7.8	8.4	
>94	9.1	9.3	9.2	14.5	11.5	13.0	
mean (95% CI)	79.88 (59.22 - 100.55)			82.07 (60.39 - 103.74)			<0.001[b]
Waist-hip ratio (%)							<0.001[a]
<0.8	2.6	4.2	3.4	5.4	5.8	5.6	
0.8-0.84	11.3	9.5	10.4	13.9	14.5	14.2	
0.85-0.89	24.0	20.4	22.2	22.9	27.4	25.2	
≥0.9	62.1	65.9	64.0	57.8	52.3	55.0	
mean (95% CI)	0.925 (0.791 - 1.059)			0.907 (0.774 -1.040)			<0.001[b]
Systolic blood pressure, mmHg (%)							<0.001[a]
<120	55.6	56.9	56.3	67.9	65.4	66.6	
120-129	23.2	18.5	20.8	14.7	14.9	14.8	
130-139	10.7	11.9	11.3	7.8	8.2	8.0	
≥140	10.5	12.7	11.6	9.6	11.5	10.6	
mean (95% CI)	120.36 (86.89 - 153.84)			115.73 (80.29 - 151.17)			<0.001[b]
Diastolic blood pressure, mmHg (%)							0.587[a]
<80	58.9	59.7	59.3	60.6	63.2	61.9	
80-84	15.9	14.1	15.0	14.1	13.1	13.6	
85-89	11.5	11.5	11.5	10.0	10.5	10.3	
≥90	13.7	14.7	14.2	15.3	13.1	14.2	
mean (95% CI)	78.40 (55.87 - 100.93)			77.96 (56.01 - 99.91)			0.384[b]
HbA1c, % (%)							0.001[a]
<5.7	51.4	48.8	50.1	49.6	46.3	48.0	
5.7-6.4	35.1	34.5	34.8	31.1	30.6	30.9	
≥6.5	13.5	16.7	15.1	19.3	23.1	21.2	
median (IQR)	5.6 (5.3 - 6.1)			5.7 (5.3 - 6.3)			0.033[c]

Random blood glucose, mg/dL (%)							0.204[a]
<140	93.3	91.3	92.3	89.2	90.9	90.0	
140-199	3.6	3.4	3.5	5.6	3.6	4.6	
≥200	3.2	5.4	4.3	5.2	5.6	5.4	
median (IQR)		95 (85 - 108)			95 (85 - 108)		0.148[c]
Total cholesterol, mg/dL (%)							<0.001[a]
<150	36.1	36.5	36.3	27.7	30.2	29.0	
150-189	40.1	37.7	38.9	37.1	38.2	37.7	
190-199	4.4	6.9	5.7	8.6	8.3	8.5	
200-239	15.1	14.7	14.9	19.9	17.7	18.8	
≥240	4.4	4.2	4.3	6.6	5.6	6.1	
mean (95% CI)		166.50 (91.33 - 241.67)			174.16 (94.08 -254.25)		<0.001[b]
HDL-cholesterol, mg/dL (%)							<0.001[a]
<40	73.8	72.8	73.3	57.1	54.9	56.0	
40-49	20.4	19.2	19.8	27.2	27.4	27.3	
≥50	5.8	7.9	6.8	15.7	17.7	16.7	
median (IQR)		33 (27 - 40)			38 (32 - 46)		<0.001[c]
LDL-cholesterol, mg/dL (%)							0.805[a]
<100	54.3	58.3	56.3	51.4	57.4	54.4	
100-129	34.2	30.0	31.1	34.5	31.1	32.8	
130-159	9.5	9.3	9.4	11.0	9.8	10.4	
≥160	2.0	2.4	2.2	3.0	1.8	2.4	
mean (95% CI)		96.94 (42.85 - 151.03)			98.99 (44.54 - 153.45)		0.097[b]
Triglycerides, mg/dL (%)							<0.001[a]
<100	24.6	30.2	27.4	36.7	36.0	36.4	
100-149	25.0	22.8	23.9	25.5	24.7	25.1	
150-199	19.4	14.1	16.8	15.5	16.9	16.2	
≥200	31.0	32.9	31.9	22.3	22.5	22.4	
median (IQR)		147 (95 - 229)			122 (83 - 187)		<0.001[c]
Hemoglobin, mg/dL (%)							<0.001[a]
<11	1.6	2.0	1.8	13.9	15.3	14.6	
11-11.9	3.6	3.6	3.6	25.3	29.0	27.2	
12-12.9	6.2	9.5	7.8	39.0	33.2	36.1	
13-16.9	88.1	84.1	86.1	21.9	22.5	22.2	
≥17	0.6	0.8	0.7	0.0	0.0	0.0	
mean (95% CI)		14.22 (11.57 - 16.87)			12.05 (9.65 - 14.45)		<0.001[b]

Abbreviation: CI, confidence interval; IQR, interquartile range; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein
Gender differences between all men and all women were tested by [a] chi-squared test, [b] t-test, and [c] Mann-Whitney test.

Table 3 Prevalence of physical and biochemical risk factors of non-communicable diseases by gender and household wealth status, % (95% CI)

	Men			Women			*p* for gender difference[a]
Household wealth status	Housing level 1	Housing level 2	All	Housing level 1	Housing level 2	All	
Overweight or obesity BMI ≥25 kg/m^2	21.2 (17.6-24.8)	17.5 (14.1-20.8)	19.3 (16.9-21.8)	39.4 (35.1-43.7)	39.2 (34.9-43.4)	39.3 (36.2-42.3)	<0.001
Obesity BMI ≥30 kg/m^2	2.0 (0.7-3.2)	1.6 (0.5-2.7)	1.8 (1.0-2.6)	8.4 (6.0-10.9)	9.7 (7.1-12.3)	9.1 (7.3-10.9)	<0.001
Large waist circumference							
men >90 cm, women >80 cm	16.7 (13.4-19.9)	15.9 (12.7-19.1)	16.3 (14.0-18.6)	53.0 (48.6-57.4)	53.5 (49.1-57.9)	53.2 (50.1-56.3)	<0.001
men >94 cm, women >80 cm	9.1 (6.6-11.6)	9.3 (6.8-11.9)	9.2 (7.4-11.0)	53.0 (48.6-57.4)	53.5 (49.1-57.9)	53.2 (50.1-56.3)	<0.001
Large waist-hip ratio men ≥0.9, women ≥0.85	62.1 (57.9-66.4)	65.9 (61.7-70.0)	64.0 (61.0-67.0)	80.7 (77.2-84.2)	79.7 (76.2-83.2)	80.2 (77.8-82.7)	<0.001
Hypertension							
SBP ≥140 mmHg or DBP ≥90 mmHg	16.9 (13.6-20.1)	18.1 (14.7-21.4)	17.5 (15.1-19.8)	16.5 (13.2-19.7)	16.7 (13.4-20.0)	16.6 (14.3-18.9)	0.601
SBP ≥140 mmHg or DBP ≥90 mmHg or on medication	18.3 (14.9-21.6)	18.8 (15.4-22.3)	18.6 (16.1-21.0)	20.3 (16.7-23.8)	20.9 (17.3-24.4)	20.6 (18.1-23.1)	0.252
Diabetes:							
HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment.	13.7 (10.7-16.7)	16.9 (13.6-20.1)	15.3 (13.1-17.5)	20.7 (17.1-24.3)	23.7 (19.9-27.4)	22.2 (19.6-24.8)	<0.001

Raised total cholesterol							
≥190 mg/dL	23.8 (20.1-27.5)	25.8 (22.0-29.6)	24.8 (22.1-27.5)	35.1 (30.9-39.9)	31.6 (27.5-35.7)	33.4 (30.4-36.3)	<0.001
≥190 mg/dL or on medication	24.4 (20.6-28.2)	26.6 (22.7-30.5)	25.5 (22.8-28.2)	35.9 (31.7-40.2)	32.8 (28.7-36.9)	34.4 (31.4-37.3)	0.001
Low HDL-cholesterol							
both men and women <40 mg/dL	73.8 (67.0-77.7)	72.8 (68.9-76.7)	73.3 (70.6-76.0)	57.1 (52.8-61.5)	54.9 (50.5-59.2)	56.0 (52.9-59.1)	<0.001
men <40 mg/dL, women <50 mg/dL	73.8 (67.0-77.7)	72.8 (68.9-76.7)	73.3 (70.6-76.0)	84.1 (80.9-87.4)	82.3 (79.0-85.7)	83.2 (80.9-85.5)	<0.001
Raised LDL-cholesterol ≥130 mg/dL	11.7 (8.9-14.8)	11.7 (8.9-14.5)	11.7 (9.7-13.7)	14.1 (11.0-17.1)	11.7 (8.9-14.6)	12.9 (10.8-15.0)	0.420
Raised triglycerides ≥150 mg/dL	50.4 (46.0-54.8)	47.0 (42.7-51.4)	48.7 (45.6-51.8)	37.8 (33.5-42.0)	39.4 (35.1-43.6)	38.6 (35.5-41.6)	<0.001

Abbreviation: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Gender differences between all males and all females were tested by chi-squared test.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3–4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6–7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7–10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7–10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7–9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6, 9–11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9–11
Bias	9	Describe any efforts to address potential sources of bias	10–11
Study size	10	Explain how the study size was arrived at	7–9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	11–12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8, 11–12
		(*b*) Describe any methods used to examine subgroups and interactions	11–12
		(*c*) Explain how missing data were addressed	11
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8–9, 12
		(b) Give reasons for non-participation at each stage	8–9, 12
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12–13 24–25
		(b) Indicate number of participants with missing data for each variable of interest	11
Outcome data	15*	Report numbers of outcome events or summary measures	12–14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence	NA

		interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	11–12 26–29
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	3, 5, 15, 17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	5, 17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15–17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

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Prevalence of non-communicable disease risk factors among the poor living in a shantytown in Dhaka city, Bangladesh: a community based cross-sectional survey

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Prevalence of non-communicable disease risk factors among the poor living in a shantytown in Dhaka city, Bangladesh: a community based cross-sectional survey

Md. Khalequzzaman[1], Chifa Chiang[2], Sohel Reza Choudhury[3], Hiroshi Yatsuya[2, 4], Mohammad Abdullah Al-Mamun[3], Abubakr Ahmed Abdullah Al-Shoaibi[2], Yoshihisa Hirakawa[2], Bilqis Amin Hoque[5], Syed Shariful Islam[1], Akiko Matsuyama[6], Hiroyasu Iso[7], and Atsuko Aoyama[2*]

[1] Department of Public Health and Informatics, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

[2] Department of Public Health and Health Systems, Nagoya University School of Medicine, Nagoya, Japan

[3] Department of Epidemiology and Research, National Heart Foundation Hospital and Research Institute, Dhaka, Bangladesh

[4] Department of Public Health, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

[5] Environment and Population Research Center, Dhaka, Bangladesh

[6] Nagasaki University School of Tropical Medicine and Global Health, Nagasaki, Japan

[7] Public Health Graduate School of Medicine, Osaka University, Suita, Osaka, Japan

*Corresponding author: Atsuko Aoyama, MD, PhD

Department of Public Health and Health Systems, Nagoya University School of Medicine

65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan

e-mail: atsukoa@med.nagoya-u.ac.jp

telephone: +81-52-744-2108

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ABSTRACT

Objectives: This study aims to describe non-communicable disease (NCD) risk factor prevalence of the urban poor in Bangladesh.

Design: We conducted a community based cross-sectional epidemiological study.

Setting: The study was conducted in a shantytown in Dhaka city. There were 21 050 adults aged 18 to 64 years living in 8604 households. Those households were categorized into two wealth strata based on the housing structure.

Participants: The study targeted 18-64 year old residents. A total of 2986 eligible households with one eligible individual were selected by random sampling stratified by household wealth status. A total of 2551 residents completed the questionnaire survey, and 2009 participated in the subsequent physical and biochemical measurements.

Outcome measures: A modified WHO STEPS instrument was used for assessing behavioral risk factors and physical and biochemical measurements including glycated hemoglobin (HbA1c). Prevalence of NCD risk factors, such as tobacco use, fruit and vegetable intake, overweight/obesity, hypertension, diabetes (HbA1c ≥6.5%), and dyslipidemia according to the household wealth status and their differences by gender were described.

Results: Prevalence of current tobacco users was 59.4% in men and 21.7% in women. Most of them (91.6%) consumed more than 1 serving of fruits and vegetables per day, however, only 2.5% had more than 5 servings. Overweight/obesity was more common in women (39.3%) than in men (19.4%), while underweight was more common in men (20.5%) than in women (7.1%). Prevalence of hypertension was 18.6% in men and 20.6% in women. Prevalence of diabetes was 15.3% in men and 22.2% in women, much higher than the estimated national prevalence (7%). The prevalence of raised total cholesterol was 25.5% in men and 34.4% in women.

Conclusions: The study identified tobacco use, both overweight and underweight, diabetes, hypertension, and dyslipidemia were prevalent among the urban poor in Bangladesh.

Strengths and limitations of this study:

- This study is the first population based survey including measurement of glycated hemoglobin (HbA1c) and blood lipid profile in an urban setting of Bangladesh.
- This study targeted the urban poor, the underserved high risk population, using representative sampling methods.
- Analyzing blood samples by high-performance automatic equipment in a reliable clinical laboratory, but not by portable devices often used for STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count.
- This study targeted only one urban poor community, which may not represent the nationwide situation.
- We could not measure fasting blood samples, but used HbA1c as a useful alternative.
- The prevalence of total participants was obtained from an unweighted analysis. However, the same gender differences were observed in stratified analysis by the housing level.

INTRODUCTION

Non-communicable diseases (NCDs) are globally recognized threats, thus reducing the burden of NCDs has been included as one of the targets of the Sustainable Development Goals [1]. NCDs are new priorities and additional burdens on health in low and middle income countries, where urbanization and lifestyle changes are advancing rapidly. In addition, low birth weight and childhood malnutrition among the poor may increase the risks of cardiovascular diseases and diabetes in adulthood [2, 3].

Bangladesh is a lower-middle income country in South Asia, with over 160 million population in 2015 [4]. While infectious diseases are still prevalent, the burden of NCDs is also increasing even among the poor [5]. Population-based NCD risk factor surveys by a standardized method of the World Health Organization (WHO), *i.e.* STEPwise approach to surveillance (STEPS) [6], had been conducted four times in the past in Bangladesh [7-11]. The WHO STEPS approach is a simple, standardized and flexible method, which any countries can implement for monitoring NCD risk factors, and allows comparison across countries. The STEPS instrument includes: Step 1, questionnaire-based assessment of behavioral risk factors, such as tobacco use, alcohol consumption, diet and physical activity; Step 2, physical measurements of weight, height, waist and hip circumferences, and blood pressure; and Step 3, biochemical measurements of fasting blood glucose and blood lipids such as total cholesterol. The STEPS surveys of 2002, 2010, and 2013 implemented only Step 1 and 2. The 2006 survey conducted Step 3, measurement of blood glucose and total cholesterol, as well. The 2013 STEPS reported prevalence of overweight/obesity as 25.7% (urban 29%, rural 23%), hypertension as 21.4% (urban 27%, rural 18%), and tobacco use as 43.9% (urban 45%, rural 43%) [9]. The 2006 STEPS reported prevalence of diabetes as 5.5% and raised total cholesterol as 6.9% [10]. Another population-based survey on blood lipid profile including high-density lipoprotein (HDL)-cholesterol, low-density lipoprotein

(LDL)-cholesterol and triglycerides was conducted in 2001, targeting less than 500 rural residents [12].

Urban population is rapidly increasing, as indicated by 3.4% annual urban population growth in comparison with 1.2% in the whole nation [4]. Along with the population growth of the urban poor, the burden of NCDs is increasing, due to the lifestyle changes and possible childhood undernutrition. However, the situation of NCDs and their risk factors among the urban poor has not been known yet, and data and information on prevalence of NCD risk factors are mostly unavailable.

We conducted a cross-sectional epidemiological study on NCD risk factors applying a modified WHO STEPS procedure, and a qualitative study on perception and attitude towards NCD risk factors, targeting people in an urban poor community in Bangladesh. This paper aims to describe the prevalence of NCD risk factors among the urban poor in Dhaka city, Bangladesh.

METHODS

Study site and study population

We conducted the study in Bauniabadh, an urban poor community in Dhaka city, Bangladesh [13]. The community was originally established by the government in 1972 as a settlement for the poor. An equal size land plot was allocated to each household at an affordable price. Since then, many residents moved in or out without registration, and the community expanded with sprawling shantytown outside the original boundary. Although the original residents were equally poor, some of the current residents are relatively well-off by buying up several plots to build brick houses, while others remain very poor sharing shanties made of bamboo and tin.

We defined the target population of this study as adults between 18 and 64 years of age

who lived within the original boundary of Bauniabadh. Since accurate census data were not available, we conducted a census-like baseline survey targeting all households within the original boundary between August and November 2014. Persons or family members who made common provision of food and resided under the same roof were regarded as members of the same household. We identified 8604 households with 34 170 residents, among whom 21 050 were adults between 18 and 64 years of age. The details of the household survey were described elsewhere [14].

While all dwellers of the shantytown were recognized as the urban poor, the findings of the baseline survey indicated that household wealth status somewhat varied among them. We categorized household wealth status into two groups: "housing level 1" households were defined as those living in single- or multi-storied houses with concrete roofs, concrete floors, and brick walls; and "housing level 2" households were defined as those living in houses with tin roofs, mud or wooden floors, and brick, thatch, or bamboo walls. Housing level 1 households usually have their own kitchens and toilets, while several housing level 2 households share a kitchen and a toilet. The baseline survey data showed that 39% of the population in the community belonged to the housing level 1 group, while 61% belonged to the housing level 2 group. There was no difference in the proportion of gender between the two groups.

Sampling

We applied stratified random sampling procedure according to gender and the housing wealth status. Target sample size was calculated using the mean and standard deviation of BMI (20.9 and 4.2, respectively in men) from the 2010 STEPS Survey [11]. We set the difference in the mean BMI between housing level groups to be 1.0, and type I and II errors to be 0.05 and 0.2, respectively. Although the necessary sample size was calculated to be approximately 300, we decided to sample 500 individuals in each housing level and gender stratum to obtain enough statistical power (at least 2000 subjects in total). Since only one person was sampled from one household, we randomly selected 1000 households for men and 1000 households for women in each housing level group at the outset of the study. In total, 4000 households were selected, considering the possibilities that an eligible person may be unavailable in the assigned household or decline participation as suggested by the STEPS survey guideline (80% response rate) [6]. We recruited one adult aged 18-64 years from each selected household by using Kish grid [15], until the total recruited subjects in each stratum surpassed 500. Pregnant women were excluded. We visited 3560 out of 4000 selected households as the number of individuals with complete data reached 2000. Specifically, among the 3560 selected households, 576 households were found ineligible due to absence of any eligible persons. Out of 2986 eligible households with one eligible person, 435 selected persons declined or were unavailable. Finally, 2551 subjects completed the interview conducted at their home (interview response rate: 85.4%) and 2009 subjects came to a study clinic in the National Heart Foundation Hospital and Research Institute to complete physical and biochemical measurements (response rate: 67.3%).

Staff training and community mobilization

Four men and two women who completed college education and had experience of field studies were recruited as interviewers, and trained for five days on interview skills. Two supervisors managed field activities and monitored data quality. Nurses and laboratory technicians of the National Heart Foundation Hospital and Research Institute were trained to conduct the standard physical measurements following WHO guidelines.

For encouraging people to participate in the survey, meetings with community leaders and other representatives were held in the community several times before and during the survey period. Community leaders were actively involved in motivating people to participate. Community women who worked as surveyors of our previous baseline study were assigned as community mobilizers. They provided counseling for the selected persons.

Data collection

The field epidemiological study was conducted from October 2015 to April 2016, mostly following the standard WHO STEPS procedures [6]. We used a modified questionnaire of 2010 Bangladesh STEPS [8], which consisted of all core questions and some expanded questions in the WHO prototype and additional questions such as types of tobacco. We also incorporated the findings of qualitative studies conducted between November 2014 and August 2015 [16] and added several questions such as those related to salt intakes. The questionnaire was pretested in adjacent shantytowns and revised several times until all interviewers became confident in completing the interviews.

The interviewers visited the selected household and interviewed the eligible person in Bengali language. Participants who completed the interview were invited to the study clinic in the National Heart Foundation Hospital and Research Institute for physical measurements and blood sampling. The Institute was close to the community and transport cost was provided when a participant showed up. Those who failed to show up were reminded and motivated by the community mobilizers.

Participants were asked about their medical histories and medications, then height, weight, waist and hip circumferences, and blood pressure were measured. Female nurses conducted the anthropometric measurement of women participants. The anthropometric measurements were taken in light clothing without shoes or other heavy accessories. After resting 15 minutes, blood pressure was measured three times in the right upper arm by using automatic digital sphygmomanometer (HEM-8712, OMRON Corporation, Japan). Systolic blood pressure

(SBP), diastolic blood pressure (DBP), and pulse per minute were recorded, and the arithmetic mean of the second and third readings of blood pressure was used for the analysis. In case of arrhythmia, blood pressure was measured twice by manual sphygmomanometer.

The poor people, who worked very early in the morning, could come to the study clinic only in the afternoon. Thus, random blood samples were taken to measure glucose, glycated hemoglobin (HbA1c), total, HDL- and LDL-cholesterol, triglycerides, and complete blood count. About 10 ml of venous blood was drawn and analyzed at the clinical laboratory of the National Heart Foundation Hospital and Research Institute, using calibrated automatic analyzers (Dimension RxL Max, Siemens, USA, for glucose, total, HDL- and LDL-cholesterol, triglycerides and HbA1c; and Hematology Analyzer Mythic 22, Orphee, Switzerland, for hemoglobin, red blood cell, white blood cell and platelet counts).

Data analysis

The participants' names were separated from the original sheets, which were coded with serial numbers. The anonymized data were entered in a programmed data entry template and the accuracy of the data entry was verified using 10% double-entry method. There were no missing variables in the present analyses except for one person's gender. We excluded the subject from the data analysis.

We categorized all continuous readings of physical and biochemical measurements according to well-defined standards. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, and then categorized into four groups: <18.5, 18.5–24.9, 25–29.9, and ≥30 kg/m^2 [17]. Hypertension was defined as SBP ≥140 mmHg, or DBP ≥90 mmHg, or use of any antihypertensive medication [18]. Random blood glucose levels were classified as: <140, 140-199, and ≥200 mg/dL; and HbA1c levels as: <5.7, 5.7–6.4, and ≥6.5% [19]. Blood lipid levels were classified by the following cutoff values: total cholesterol levels as <150, 150–189, 190–199, 200–239, ≥240 mg/dL; HDL-cholesterol levels as <40, 40–49, ≥50 mg/dL; LDL-cholesterol levels as <100, 100–129, 130–159, ≥160 mg/dL; triglyceride levels as <100, 100–149, 150–199 and ≥200 mg/dL [20, 21].

The prevalence in total men or women regardless of the sampling unit of housing level was obtained from unweighted analyses. To test differences between men and women on each categorical data, chi-squared test was applied. Student's t-test was used for testing difference of means across gender. For data with skewed distributions, Mann-Whitney U test was used to test the differences. All of the statistical analyses were performed using the statistical software, IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY, USA).

Ethical considerations

This study was approved by the Bioethics Review Committee of Nagoya University School of Medicine, Japan (approval no. 2014-0021). Institutional Review Boards of Bangabandhu Sheikh Mujib Medical University and National Heart Foundation Hospital and Research Institute, Bangladesh, approved the study as well. Written informed consent was obtained from all participants. Participants with no education provided fingerprints on the consent sheets after receiving sufficient verbal explanation.

RESULTS

In total, 2551 eligible persons participated in the questionnaire-based interview: 1289 (674 men and 615 women) were from the housing level 1 group and 1262 (684 men and 578 women) were from the housing level 2 group. Among the interview participants, 2009 persons (78.8%) participated in the physical and biochemical measurements, of whom 1002 (504 men and 498 women) were from the housing level 1 group and 1007 (504 men and 503 women) were from the housing level 2 group.

Table 1 shows demographic and behavioral characteristics. Mean age of the 2551 participants was 35.5 years. Current tobacco users were 59.4% of men (54.6% in the housing level 1 and 64.2% in the housing level 2) and 21.7% of women (14.8% in the housing level 1 and 29.1% in the housing level 2). Tobacco smoking (cigarette, *beedi*, *etc.*) was reported only from men (52.3% in total, 48.7% in the housing level 1 and 55.8% in the housing level 2). Smokeless tobacco chewing was more common in women (21.7% in total, 14.8% in the housing level 1 and 29.1% in the housing level 2) than men (15.5% in total, 11.6% in the housing level 1 and 19.3% in the housing level 2). Alcohol drinking was reported only from men (3.5% in total, 4.6% in the housing level 1 and 2.3% in the housing level 2).

Most of them (92.9% of men and 90.3% of women) consumed at least 1 serving of fruits and vegetables per day, however, those who had more than 5 servings were only 0.8% of men and 4.2% of women. Those who had less than 1 serving were 7.1% of men (7.3% in the housing level 1 and 6.9 % in the housing level 2) and 9.7% of women (3.3% in the housing level 1 and 16.5% in the housing level 2). Only 20.4% of men and 21.0% of women reported that they never added table salt to their meals, while 58.3% of men and 54.4% of women always took additional salt. Prevalence of moderate or high level of total physical activity (≥600 MET-minutes per week) was 75.3% in men and 31.9% in women, which is comparable with the findings of the urban population of 2010 STEPS [22].

Comparing to the housing level 1 group, the housing level 2 group participants were less likely to: be educated, be employed, have fruits and vegetables; and add salt. They were more likely to be: day laborers; tobacco users; and physically active (*P* <0.05 for all, not shown in the Tables).

Table 2 shows the percentages of biological indicators classified by appropriate criteria, and Table 3 shows prevalence of biological NCD risk factors by gender and household wealth status. Overweight/obesity was more common in women (39.3%) than men (19.4%), while underweight was more common in men (20.5%) than women (7.1%). Overweight/obesity prevalence was higher than the estimated national prevalence of men (16.4%) and women (24.2%) [23].

According to WHO recommended cut-off points [24], prevalence of increased waist circumference (men >94 cm; women >80 cm) and increased waist-hip ratio (men ≥0.90; women ≥0.85) were 9.2% and 64.0% in men and 53.2% and 80.2% in women, respectively. Prevalence of increased waist circumference in men was 16.2%, according to the cut-off point for south Asian men (>90 cm) recommended by International Diabetes Federation [24].

The prevalence of hypertension was 18.6% in men and 20.6% in women, which was comparable with the findings of previous STEPS surveys [9-11].

Prevalence of diabetes (HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment) [19] was 15.3% in men (13.7% in the housing level 1 and 16.9% in the housing level 2) and 22.2% in women (20.7% in the housing level 1 and 23.7% in the housing level 2), much higher than the WHO estimated national prevalence (men 8.6%; women 7.4%) [23]. Only 4.3% of men and 5.4% of women showed diabetes level of random blood glucose, indicating unreliability of random blood glucose for screening diabetes.

Mean value of total cholesterol was 166.5 mg/dL in men and 174.2 mg/dL in women, and median value of HDL-cholesterol was as low as 33 mg/dL in men and 38 mg/dL in women. The prevalence of raised total cholesterol (≥190mg/dL or on medication) was 25.5% in men and 34.4% in women, respectively. High risk range of low level HDL-cholesterol (<40 mg/dL) [20] was 73.3% in men and 56.0% in women, and borderline-high/high level LDL-cholesterol (≥130 mg/dL) [20] was 11.7% in men and 12.9% in women. High level triglycerides (≥200 mg/dL) [20] was more common in men (31.9%) than women (22.4%).

Regarding the prevalence of physical and biochemical risk factors, such as overweight/obesity, hypertension, diabetes and dyslipidemia, significant difference was not found between the housing level 1 and the housing level 2 groups (not shown in Tables).

DISCUSSION

This study is the first comprehensive epidemiological survey of various NCD risk factors including HbA1c among the urban poor in Bangladesh, who are considered to be an underserved high risk population.

We found that overweight/obesity prevalence of both men and women was higher than the estimated national prevalence. Overweight/obesity prevalence in women was as high as 40%, which could be attributed to the sedentary lifestyle of urban women [25]. Overweight/obesity and underweight were equally prevalent in men, reflecting their socio-economic situation: many men still had to be involved in hard physical labor [26], while some men could afford to eat well. Our findings suggested that both overweight/obesity and underweight should be addressed simultaneously.

High prevalence of increased waist-hip ratio in both men and women and increased waist circumference in women indicated high risks of metabolic syndrome among the urban poor. However, it would require further studies to identify appropriate cut-off points and clinical implications of BMI, waist circumference, and waist-hip ratio in Bangladesh, considering the discrepancy between waist circumference and waist-hip ratio in men.

The prevalence of diabetes in both housing levels and in both genders were much higher than the WHO estimated national prevalence [23], and the findings of the 2006 STEPS survey (men 7.6%; women 2.8%) [10]. The findings of our study were in line with the increasing trend reported elsewhere [23], therefore, diabetes prevalence may have increased since the last surveys. Diabetes prevalence of the poor may be higher than the national average, indicating an association of low socio-economic status and increased diabetes prevalence, as studies in high income countries showed [27, 28]. The higher diabetes prevalence among the urban poor may be attributed to childhood undernutrition, but further investigation is required.

Diabetes prevalence was higher in women than men, contrary to the findings of the 2006 survey. The urban poor women may be more prone to diabetes than men, since gender difference in diabetes prevalence may vary depending on socio-economic situations [29]. However, the higher HbA1c level in women than men might have been due to higher prevalence of anemia (hemoglobin <11 mg/dL) [30] in women (14.6%) than men (1.8%), which was reported to shift HbA1c values toward higher ends [31-34]. In our study, we used the WHO recommended HbA1c cut-off point [35], but caution is needed in light of the high anemia prevalence. Further studies are required to fully understand and interpret HbA1c values in low and lower-middle income countries.

Our study is the first population-based survey of blood lipid profile of the urban poor in Bangladesh. High risk range of low HDL-cholesterol was highly prevalent, but desirable range of low total cholesterol and LDL-cholesterol were both highly prevalent as well. The findings were consistent with the findings of a previous study of a rural population, although desirable range of low LDL-cholesterol was more prevalent in our study than that in the previous one [12]. Clinical implications of low levels of HDL- and LDL-cholesterol of this population need to be investigated further. Relatively high prevalence of high level triglycerides might be overestimated, as random blood samples were used.

High prevalence of tobacco use was confirmed in this study. This is consistent with previous studies [36, 37]. Chewing tobacco products seemed to be culturally tolerated, as shown that women often chewed tobacco but refrained smoking tobacco. Different approaches for men and women need to be developed for controlling tobacco.

About 80% of the participants added table salt to their meals, although the meals were cooked and seasoned with salt. Further studies are needed to determine the amount of salt intake of this population, as we did not measure total salt intake. Our qualitative study found that people in the community sprinkled table salt on rice because they liked salty taste and served salt with meal for welcoming guests [16]. While salt reduction is known to be a cost effective strategy to prevent cardiovascular diseases [38, 39], modifying dietary habit of individuals in short time would be very difficult. Thus, a long term community wide campaign to modify diet is required, as shown in successful examples in Japan [40, 41].

The strength of this study is that we targeted the urban poor, an underserved high risk population, using representative sampling methods. Analyzing blood samples by high-performance automatic equipment in a reliable clinical laboratory, but not by portable devices often used by STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count. However, this study has several limitations. First, we targeted only one urban poor community, which may not represent nationwide situation. Second, we could not measure fasting blood samples. While random blood glucose value was unreliable for screening diabetes, we found measuring HbA1c could be a useful alternative. Third, unweighted prevalence was presented for the prevalence of total participants in the present analysis. However, we refrained from drawing conclusions using unweighted prevalence, and we depicted prevalence separately for the housing level 1 and 2 when appropriate. Nevertheless, it should be noted that prevalence estimates presented for all participants, where the housing level 1 group (39% of total population) over-represented, might not represent the whole target population.

In conclusion, the current survey revealed high prevalence of NCD risk factors among the urban poor in Bangladesh. Diabetes, dyslipidemia, hypertension, tobacco use, and both overweight and underweight were prevalent, indicating the dual burden among the urban poor. Our findings can serve as baseline epidemiological data and help policymakers develop appropriate NCD control strategies.

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Contributors A.A., M.K., S.R.C., H.Y., and A.M. designed the study, M.K., S.R.C., M.A.A., B.A.H. and S.S.I. conducted the field survey and data collection, C.C., M.K., H.Y., S.R.C., and A.A. statistically analyzed and interpreted the data, A.A., M.K., C.C., and A.A.A.A. drafted the manuscript, H.Y., S.R.C., H.I., S.S.I., A.M., and Y.H. provided critical inputs on the draft. All authors approved the final draft.

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Competing interests None declared.

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Table 1. Demographic and behavioral characteristics of participants by gender and household wealth status

Household wealth status	Men			Women			p for gender difference [a]
	Housing level 1	Housing level 2	All	Housing level 1	Housing level 2	All	
Number	674	684	1358	615	578	1193	
Age group of years (%)							0.986
18-24	19.4	14.9	17.2	17.7	16.1	16.9	
25-34	35.0	32.9	33.9	37.1	31.0	34.1	
35-44	26.6	25.6	26.1	24.7	28.9	26.7	
45-54	13.9	15.9	14.9	13.7	14.9	14.2	
55-64	5.0	10.7	7.9	6.8	9.2	8.0	
mean (95% CI)	34.4 (33.5-35.2)	36.8 (35.9-37.6)	35.6 (35.0-36.2)	34.3 (33.4-35.2)	36.4 (35.5-37.3)	35.3 (34.7-36.0)	0.586
Years of education (%)							<0.001
none	22.0	32.6	27.3	31.5	45.0	38.1	
1-4	10.5	17.4	14.0	15.9	23.0	19.4	
5-7	24.5	19.6	22.0	29.6	18.3	24.1	
8-9	20.7	16.5	18.6	13.2	8.5	10.9	
≥10	22.3	13.9	18.1	9.8	5.2	7.5	
Religion (%)							0.406
Islam	98.7	96.3	97.5	98.9	97.1	98.0	
Hinduism	1.3	3.7	2.5	1.1	2.9	2.0	
Marital status (%)							<0.001
unmarried	15.4	13.6	14.5	0.7	1.4	1.0	
married	84.6	85.8	85.2	90.2	85.3	87.8	
others	0.0	0.6	0.3	9.1	13.3	11.1	

Occupation (%)							<0.001
employed	22.8	13.6	18.2	17.4	14.0	15.8	
self-employed	44.2	43.1	43.7	3.6	13.3	8.3	
day labor	23.7	30.0	26.9	2.0	7.1	4.4	
homemaker	0.3	0.1	0.2	75.8	64.4	70.2	
others	8.9	13.2	11.0	1.3	1.2	1.3	
Any form of tobacco (%)							<0.001
non-user	39.3	30.8	35.1	84.2	68.2	76.4	
ex-user	6.1	5.0	5.5	1.0	2.8	1.8	
current user	54.6	64.2	59.4	14.8	29.1	21.7	
Tobacco smoking (%)							<0.001
non-smoker	43.6	38.7	41.2	99.5	98.1	98.8	
ex-smoker	7.7	5.4	6.6	0.5	1.9	1.2	
current smoker	48.7	55.8	52.3	0.0	0.0	0.0	
Smokeless tobacco chewing (%)							<0.001
non-user	87.8	78.4	83.1	84.6	68.9	76.9	
ex-user	0.6	2.3	1.5	0.7	2.1	1.3	
current user	11.6	19.3	15.5	14.8	29.1	21.7	
Alcohol drinking (%)							<0.001
non-drinker	95.4	97.7	96.5	100.0	100.0	100.0	
current drinker	4.6	2.3	3.5	0.0	0.0	0.0	
Fruit/vegetable intake, servings per day (%)							<0.001
<1	7.3	6.9	7.1	3.3	16.5	9.7	
1-2.9	61.7	67.1	64.4	57.2	72.6	64.7	
3-4.9	31.0	24.5	27.7	31.7	10.6	21.4	

≥5	0.0	1.5	0.8	7.8	0.3	4.2	
Adding salt at the table (%)							0.001
always	70.2	46.6	58.3	67.0	41.0	54.4	
often	5.9	13.3	9.6	1.6	28.5	14.7	
sometimes	5.8	17.4	11.6	10.7	9.2	10.0	
never	18.1	22.7	20.4	20.7	21.3	21.0	
Total physical activity, MET-minutes per week (%)							<0.001
<600	30.4	19.0	24.7	83.9	51.4	68.1	
600-2999	38.3	26.9	32.5	14.8	44.5	29.2	
≥3000	31.3	54.1	42.8	1.3	4.2	2.7	

Abbreviation: CI, confidence interval of mean; MET, metabolic equivalent
[a] Gender differences between all men and all women were tested by chi-squared test and t-test as appropriate.

Table 2. Physical and biochemical characteristics of participants by gender and household wealth status

	Men			Women			*p* for gender difference
Household wealth status	Housing level 1	Housing level 2	All	Housing level 1	Housing level 2	All	
Number	504	504	1008	498	503	1001	
Body mass index, kg/m^2 (%)							<0.001 [a]
<18.5	18.5	22.6	20.5	7.2	7.0	7.1	
18.5-24.9	60.3	59.9	60.1	53.4	53.9	53.6	
25-29.9	19.2	15.9	17.6	30.9	29.4	30.2	
≥30	2.0	1.6	1.8	8.4	9.7	9.1	
mean (95% CI)	21.9 (14.8-29.1)	21.6 (14.2-29.0)	21.8 (14.5-29.1)	24.2 (16.1-32.3)	24.1 (15.8-32.4)	24.2 (15.9-32.4)	<0.001 [b]
Waist circumference, cm (%)							0.001 [a]
≤80	53.8	56.2	55.0	47.0	46.5	46.8	
81-90	29.6	28.0	28.8	29.5	34.2	31.9	
91-94	7.5	6.5	7.0	9.0	7.8	8.4	
>94	9.1	9.3	9.2	14.5	11.5	13.0	
mean (95% CI)	80.2 (60.0-100.4)	79.6 (58.5-100.7)	79.9 (59.2-100.5)	82.2 (59.7-104.7)	81.9 (61.1-102.7)	82.1 (60.4-103.7)	<0.001 [b]
Waist-hip ratio (%)							<0.001 [a]
<0.8	2.6	4.2	3.4	5.4	5.8	5.6	
0.8-0.84	11.3	9.5	10.4	13.9	14.5	14.2	
0.85-0.89	24.0	20.4	22.2	22.9	27.4	25.2	
≥0.9	62.1	65.9	64.0	57.8	52.3	55.0	
mean (95% CI)	0.92 (0.79-1.05)	0.93 (0.79-1.06)	0.92 (0.79-1.06)	0.91 (0.77-1.04)	0.90 (0.77-1.04)	0.91 (0.77-1.04)	<0.001 [b]
Systolic blood pressure, mmHg (%)							<0.001 [a]
<120	55.6	56.9	56.3	67.9	65.4	66.6	
120-129	23.2	18.5	20.8	14.7	14.9	14.8	
130-139	10.7	11.9	11.3	7.8	8.2	8.0	
≥140	10.5	12.7	11.6	9.6	11.5	10.6	

mean (95% CI)	120 (90-149)	121 (84-158)	120 (87-154)	115 (80-151)	116 (81-152)	116 (80-151)	<0.001 [b]
Diastolic blood pressure, mmHg (%)							0.587 [a]
<80	58.9	59.7	59.3	60.6	63.2	61.9	
80-84	15.9	14.1	15.0	14.1	13.1	13.6	
85-89	11.5	11.5	11.5	10.0	10.5	10.3	
≥90	13.7	14.7	14.2	15.3	13.1	14.2	
mean (95% CI)	78 (57-99)	79 (55-102)	78 (56-101)	78 (56-101)	78 (56-99)	78 (56-100)	0.384 [b]
HbA1c, % (%)							0.001 [a]
<5.7	51.4	48.8	50.1	49.6	46.3	48.0	
5.7-6.4	35.1	34.5	34.8	31.1	30.6	30.9	
≥6.5	13.5	16.7	15.1	19.3	23.1	21.2	
median (IQR)	5.6 (5.3-6.0)	5.7 (5.3-6.1)	5.6 (5.3-6.1)	5.7 (5.3-6.3)	5.7 (5.3-6.4)	5.7 (5.3-6.3)	0.033 [c]
Random blood glucose, mg/dL (%)							0.204 [a]
<140	93.3	91.3	92.3	89.2	90.9	90.0	
140-199	3.6	3.4	3.5	5.6	3.6	4.6	
≥200	3.2	5.4	4.3	5.2	5.6	5.4	
median (IQR)	94 (84-106)	95 (85-108)	95 (85-107)	95 (85-108)	95 (86-108)	95 (85-108)	0.148 [c]
Total cholesterol, mg/dL (%)							<0.001 [a]
<150	36.1	36.5	36.3	27.7	30.2	29.0	
150-189	40.1	37.7	38.9	37.1	38.2	37.7	
190-199	4.4	6.9	5.7	8.6	8.3	8.5	
200-239	15.1	14.7	14.9	19.9	17.7	18.8	
≥240	4.4	4.2	4.3	6.6	5.6	6.1	
mean (95% CI)	166 (91-242)	167 (91-242)	167 (91-242)	176 (97-254)	173 (91-254)	174 (94-254)	<0.001 [b]
HDL-cholesterol, mg/dL (%)							<0.001 [a]
<40	73.8	72.8	73.3	57.1	54.9	56.0	

40-49	20.4	19.2	19.8	27.2	27.4	27.3	
≥50	5.8	7.9	6.8	15.7	17.7	16.7	
median (IQR)	32 (27-40)	33 (27-40)	33 (27-40)	38 (32-45)	38 (32-46)	38 (32-46)	<0.001 [c]
LDL-cholesterol, mg/dL (%)							0.805 [a]
<100	54.3	58.3	56.3	51.4	57.4	54.4	
100-129	34.2	30.0	31.1	34.5	31.1	32.8	
130-159	9.5	9.3	9.4	11.0	9.8	10.4	
≥160	2.0	2.4	2.2	3.0	1.8	2.4	
mean (95% CI)	97 (45-150)	96 (42-150)	97 (43-151)	101 (46-156)	97 (44-150)	99 (45-153)	0.097 [b]
Triglycerides, mg/dL (%)							<0.001 [a]
<100	24.6	30.2	27.4	36.7	36.0	36.4	
100-149	25.0	22.8	23.9	25.5	24.7	25.1	
150-199	19.4	14.1	16.8	15.5	16.9	16.2	
≥200	31.0	32.9	31.9	22.3	22.5	22.4	
median (IQR)	150 (102-224)	142 (93-242)	147 (95-229)	118 (84-188)	125 (82-186)	122 (83-187)	<0.001 [c]
Hemoglobin, mg/dL (%)							<0.001 [a]
<11	1.6	2.0	1.8	13.9	15.3	14.6	
11-11.9	3.6	3.6	3.6	25.3	29.0	27.2	
12-12.9	6.2	9.5	7.8	39.0	33.2	36.1	
13-16.9	88.1	84.1	86.1	21.9	22.5	22.2	
≥17	0.6	0.8	0.7	0.0	0.0	0.0	
mean (95% CI)	14.3 (11.7-16.8)	14.2 (11.4-16.9)	14.2 (11.6-16.9)	12.1 (9.7-14.4)	12.0 (9.6-14.5)	12.1 (9.7-14.5)	<0.001 [b]

Abbreviation: CI, confidence interval; IQR, interquartile range; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein
Gender differences between all men and all women were tested by [a] chi-squared test, [b] t-test, and [c] Mann-Whitney test.

Table 3 Prevalence of physical and biochemical risk factors of non-communicable diseases by gender and household wealth status, % (95% CI)

	Men			Women			*p* for gender difference [a]
Household wealth status	Housing level 1	Housing level 2	All	Housing level 1	Housing level 2	All	
Overweight or obesity BMI ≥25 kg/m^2	21.2 (17.6-24.8)	17.5 (14.1-20.8)	19.3 (16.9-21.8)	39.4 (35.1-43.7)	39.2 (34.9-43.4)	39.3 (36.2-42.3)	<0.001
Obesity BMI ≥30 kg/m^2	2.0 (0.7-3.2)	1.6 (0.5-2.7)	1.8 (1.0-2.6)	8.4 (6.0-10.9)	9.7 (7.1-12.3)	9.1 (7.3-10.9)	<0.001
Large waist circumference							
men >90 cm, women >80 cm	16.7 (13.4-19.9)	15.9 (12.7-19.1)	16.3 (14.0-18.6)	53.0 (48.6-57.4)	53.5 (49.1-57.9)	53.2 (50.1-56.3)	<0.001
men >94 cm, women >80 cm	9.1 (6.6-11.6)	9.3 (6.8-11.9)	9.2 (7.4-11.0)	53.0 (48.6-57.4)	53.5 (49.1-57.9)	53.2 (50.1-56.3)	<0.001
Large waist-hip ratio men ≥0.9, women ≥0.85	62.1 (57.9-66.4)	65.9 (61.7-70.0)	64.0 (61.0-67.0)	80.7 (77.2-84.2)	79.7 (76.2-83.2)	80.2 (77.8-82.7)	<0.001
Hypertension							
SBP ≥140 mmHg or DBP ≥90 mmHg	16.9 (13.6-20.1)	18.1 (14.7-21.4)	17.5 (15.1-19.8)	16.5 (13.2-19.7)	16.7 (13.4-20.0)	16.6 (14.3-18.9)	0.601
SBP ≥140 mmHg or DBP ≥90 mmHg or on medication	18.3 (14.9-21.6)	18.8 (15.4-22.3)	18.6 (16.1-21.0)	20.3 (16.7-23.8)	20.9 (17.3-24.4)	20.6 (18.1-23.1)	0.252
Diabetes:							
HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment.	13.7 (10.7-16.7)	16.9 (13.6-20.1)	15.3 (13.1-17.5)	20.7 (17.1-24.3)	23.7 (19.9-27.4)	22.2 (19.6-24.8)	<0.001
Raised total cholesterol							

≥190 mg/dL	23.8 (20.1-27.5)	25.8 (22.0-29.6)	24.8 (22.1-27.5)	35.1 (30.9-39.9)	31.6 (27.5-35.7)	33.4 (30.4-36.3)	<0.001
≥190 mg/dL or on medication	24.4 (20.6-28.2)	26.6 (22.7-30.5)	25.5 (22.8-28.2)	35.9 (31.7-40.2)	32.8 (28.7-36.9)	34.4 (31.4-37.3)	0.001
Low HDL-cholesterol							
both men and women <40 mg/dL	73.8 (67.0-77.7)	72.8 (68.9-76.7)	73.3 (70.6-76.0)	57.1 (52.8-61.5)	54.9 (50.5-59.2)	56.0 (52.9-59.1)	<0.001
men <40 mg/dL, women <50 mg/dL	73.8 (67.0-77.7)	72.8 (68.9-76.7)	73.3 (70.6-76.0)	84.1 (80.9-87.4)	82.3 (79.0-85.7)	83.2 (80.9-85.5)	<0.001
Raised LDL-cholesterol ≥130 mg/dL	11.7 (8.9-14.8)	11.7 (8.9-14.5)	11.7 (9.7-13.7)	14.1 (11.0-17.1)	11.7 (8.9-14.6)	12.9 (10.8-15.0)	0.420
Raised triglycerides ≥150 mg/dL	50.4 (46.0-54.8)	47.0 (42.7-51.4)	48.7 (45.6-51.8)	37.8 (33.5-42.0)	39.4 (35.1-43.6)	38.6 (35.5-41.6)	<0.001

Abbreviation: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Gender differences between all men and all women were tested by chi-squared test.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5–6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6–10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6–10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6–8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9–11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9–11
Bias	9	Describe any efforts to address potential sources of bias	9–11
Study size	10	Explain how the study size was arrived at	6–8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10–11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7, 10–11
		(*b*) Describe any methods used to examine subgroups and interactions	10–11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7–8, 11
		(b) Give reasons for non-participation at each stage	7–8, 11
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11–12 23–25
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	11–13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence	NA

		interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	10, 26–30
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	3, 4, 13–14, 16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4, 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14–16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

Prevalence of non-communicable disease risk factors among the poor living in a shantytown in Dhaka city, Bangladesh: a community based cross-sectional survey

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Complete List of Authors:	Khalequzzaman, Md. ; Bangabandhu Sheikh Mujib Medical University, Department of Public Health and Informatics Chiang, Chifa; Nagoya University School of Medicine, Department of Public Health and Health Systems Choudhury, Sohel Reza; National Heart Foundation Hospital and Research Institute, Department of Epidemiology and Research Yatsuya, Hiroshi; Fujita Health University School of Medicine, Department of Public Health; Nagoya University School of Medicine, Department of Public Health and Health Systems Al-Mamun, Mohammad; National Heart Foundation Hospital and Research Institute, Department of Epidemiology and Research Al-Shoaibi, Abubakr; Nagoya University School of Medicine, Department of Public Health and Health Systems Hirakawa, Yoshihisa; Nagoya University School of Medicine, Department of Public Health and Health Systems Hoque, Bilqis; Environment and Population Research Center Islam, Syed; Bangabandhu Sheikh Mujib Medical University, Department of Public Health and Informatics Matsuyama, Akiko; Nagasaki University School of Tropical Medicine and Global Health Iso, Hiroyasu; Osaka University Public Health Graduate School of Medicine Aoyama, Atsuko; Nagoya University School of Medicine, Department of Public Health and Health Systems

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Prevalence of non-communicable disease risk factors among the poor living in a shantytown in Dhaka city, Bangladesh: a community based cross-sectional survey

Md. Khalequzzaman[1], Chifa Chiang[2], Sohel Reza Choudhury[3], Hiroshi Yatsuya[2, 4], Mohammad Abdullah Al-Mamun[3], Abubakr Ahmed Abdullah Al-Shoaibi[2], Yoshihisa Hirakawa[2], Bilqis Amin Hoque[5], Syed Shariful Islam[1], Akiko Matsuyama[6], Hiroyasu Iso[7], and Atsuko Aoyama[2*]

[1] Department of Public Health and Informatics, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

[2] Department of Public Health and Health Systems, Nagoya University School of Medicine, Nagoya, Japan

[3] Department of Epidemiology and Research, National Heart Foundation Hospital and Research Institute, Dhaka, Bangladesh

[4] Department of Public Health, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

[5] Environment and Population Research Center, Dhaka, Bangladesh

[6] Nagasaki University School of Tropical Medicine and Global Health, Nagasaki, Japan

[7] Public Health Graduate School of Medicine, Osaka University, Suita, Osaka, Japan

*Corresponding author: Atsuko Aoyama, MD, PhD

Department of Public Health and Health Systems, Nagoya University School of Medicine

65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan

e-mail: atsukoa@med.nagoya-u.ac.jp

telephone: +81-52-744-2108

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ABSTRACT

Objectives: This study aims to describe non-communicable disease (NCD) risk factor prevalence of the urban poor in Bangladesh.

Design: We conducted a community based cross-sectional epidemiological study.

Setting: The study was conducted in a shantytown in Dhaka city. There were 8604 households with 34 170 residents in the community. Those households were categorized into two wealth strata based on the housing structure.

Participants: The study targeted 18-64 year old residents. A total of 2986 eligible households with one eligible individual were selected by simple random sampling stratified by household wealth status. A total of 2551 residents completed the questionnaire survey, and 2009 participated in the subsequent physical and biochemical measurements.

Outcome measures: A modified WHO STEPS instrument was used for assessing behavioral risk factors and physical and biochemical measurements including glycated hemoglobin (HbA1c). Prevalence of NCD risk factors, such as tobacco use, fruit and vegetable intake, overweight/obesity, hypertension, diabetes (HbA1c ≥6.5%), and dyslipidemia according to the household wealth status and their differences by gender were described.

Results: Prevalence of current tobacco users was 60.4% in men and 23.5% in women. Most of them (90.8%) consumed more than 1 serving of fruits and vegetables per day, however, only 2.1% had more than 5 servings. Overweight/obesity was more common in women (39.2%) than in men (18.9%), while underweight was more common in men (21.0%) than in women (7.1%). Prevalence of hypertension was 18.6% in men and 20.7% in women. Prevalence of diabetes was 15.6% in men and 22.5% in women, much higher than the estimated national prevalence (7%). The prevalence of raised total cholesterol was 25.7% in men and 34.0% in women.

Conclusions: The study identified tobacco use, both overweight and underweight, diabetes, hypertension, and dyslipidemia were prevalent among the urban poor in Bangladesh.

Strengths and limitations of this study:

- This study is the first population based survey including measurement of glycated hemoglobin (HbA1c) and blood lipid profile in an urban setting of Bangladesh.
- This study targeted the urban poor, the underserved high risk population, using representative sampling methods.
- Analyzing blood samples by high-performance automatic equipment in a reliable clinical laboratory, but not by portable devices often used for STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count.
- This study targeted only one urban poor community, which may not represent the nationwide situation.
- We could not measure fasting blood samples, but used HbA1c as a useful alternative.

INTRODUCTION

Non-communicable diseases (NCDs) are globally recognized threats, thus reducing the burden of NCDs has been included as one of the targets of the Sustainable Development Goals [1]. NCDs are new priorities and additional burdens on health in low and middle income countries, where urbanization and lifestyle changes are advancing rapidly. In addition, low birth weight and childhood malnutrition among the poor may increase the risks of cardiovascular diseases and diabetes in adulthood [2, 3].

Bangladesh is a lower-middle income country in South Asia, with over 160 million population in 2015 [4]. While infectious diseases are still prevalent, the burden of NCDs is also increasing even among the poor [5]. Population-based NCD risk factor surveys by a standardized method of the World Health Organization (WHO), *i.e.* STEPwise approach to surveillance (STEPS) [6], had been conducted four times in the past in Bangladesh [7-11]. The WHO STEPS approach is a simple, standardized and flexible method, which any countries can implement for monitoring NCD risk factors, and allows comparison across countries. The STEPS instrument includes: Step 1, questionnaire-based assessment of behavioral risk factors, such as tobacco use, alcohol consumption, diet and physical activity; Step 2, physical measurements of weight, height, waist and hip circumferences, and blood pressure; and Step 3, biochemical measurements of fasting blood glucose and blood lipids such as total cholesterol. The STEPS surveys of 2002, 2010, and 2013 implemented only Step 1 and 2. The 2006 survey conducted Step 3, measurement of blood glucose and total cholesterol, as well. The 2013 STEPS reported prevalence of overweight/obesity as 25.7% (urban 29%, rural 23%), hypertension as 21.4% (urban 27%, rural 18%), and tobacco use as 43.9% (urban 45%, rural 43%) [9]. The 2006 STEPS reported prevalence of diabetes as 5.5% and raised total cholesterol as 6.9% [10]. Another population-based survey on blood lipid profile including high-density lipoprotein (HDL)-cholesterol, low-density lipoprotein

(LDL)-cholesterol and triglycerides was conducted in 2001, targeting less than 500 rural residents [12].

Urban population is rapidly increasing, as indicated by 3.4% annual urban population growth in comparison with 1.2% in the whole nation [4]. Along with the population growth of the urban poor, the burden of NCDs is increasing, due to the lifestyle changes and possible childhood undernutrition. However, the situation of NCDs and their risk factors among the urban poor has not been known yet, and data and information on prevalence of NCD risk factors are mostly unavailable.

We conducted a cross-sectional epidemiological study on NCD risk factors applying a modified WHO STEPS procedure, and a qualitative study on perception and attitude towards NCD risk factors, targeting people in an urban poor community in Bangladesh. This paper aims to describe the prevalence of NCD risk factors among the urban poor in Dhaka city, Bangladesh.

METHODS

Study site and study population

We conducted the study in Bauniabadh, an urban poor community in Dhaka city, Bangladesh [13]. The community was originally established by the government in 1972 as a settlement for the poor. An equal size land plot was allocated to each household at an affordable price. Since then, many residents moved in or out without registration, and the community expanded with sprawling shantytown outside the original boundary. Although the original residents were equally poor, some of the current residents are relatively well-off by buying up several plots to build brick houses, while others remain very poor sharing shanties made of bamboo and tin.

We defined the target population of this study as adults between 18 and 64 years of age

who lived within the original boundary of Bauniabadh. Since accurate census data were not available, we conducted a census-like baseline survey targeting all households within the original boundary between August and November 2014. Persons or family members who made common provision of food and resided under the same roof were regarded as members of the same household. We identified 8604 households with 34 170 residents, among whom 21 050 were adults between 18 and 64 years of age. The details of the household survey were described elsewhere [14].

While all dwellers of the shantytown were recognized as the urban poor, the findings of the baseline survey indicated that household wealth status somewhat varied among them. We categorized household wealth status into two groups: "housing level 1" households were defined as those living in single- or multi-storied houses with concrete roofs, concrete floors, and brick walls; and "housing level 2" households were defined as those living in houses with tin roofs, mud or wooden floors, and brick, thatch, or bamboo walls. Housing level 1 households usually have their own kitchens and toilets, while several housing level 2 households share a kitchen and a toilet. The baseline survey data showed that 39% of the population in the community belonged to the housing level 1 group, while 61% belonged to the housing level 2 group. There was no difference in the proportion of gender between the two groups.

Sampling

We applied simple random sampling procedure stratified according to gender and the household wealth status. Target sample size was calculated using the mean and standard deviation of BMI (20.9 and 4.2, respectively in men) from the 2010 STEPS Survey [11]. We set the difference in the mean BMI between housing level groups to be 1.0, and type I and II errors to be 0.05 and 0.2, respectively. Although the necessary sample size was calculated to be approximately 300, we decided to sample 500 individuals in each housing level and gender stratum to obtain enough statistical power (at least 2000 subjects in total). Since only one person was sampled from one household, we randomly selected 1000 households for men and 1000 households for women in each housing level group at the outset of the study. In total, 4000 households were selected, considering the possibilities that an eligible person may be unavailable in the assigned household or decline participation as suggested by the STEPS survey guideline (80% response rate) [6]. We recruited one adult aged 18-64 years from each selected household by using Kish grid [15], until the total recruited subjects in each stratum surpassed 500. Pregnant women were excluded. We visited 3560 out of 4000 selected households as the number of individuals with complete data reached 2000. Specifically, among the 3560 selected households, 576 households were found ineligible due to absence of any eligible persons. Out of 2986 eligible households with one eligible person, 435 selected persons declined or were unavailable. Finally, 2551 subjects completed the interview conducted at their home (interview response rate: 85.4%) and 2009 subjects came to a study clinic in the National Heart Foundation Hospital and Research Institute to complete physical and biochemical measurements (response rate: 67.3%).

Staff training and community mobilization

Four men and two women who completed college education and had experience of field studies were recruited as interviewers, and trained for five days on interview skills. Two supervisors managed field activities and monitored data quality. Nurses and laboratory technicians of the National Heart Foundation Hospital and Research Institute were trained to conduct the standard physical measurements following WHO guidelines.

For encouraging people to participate in the survey, meetings with community leaders and other representatives were held in the community several times before and during the survey period. Community leaders were actively involved in motivating people to participate. Community women who worked as surveyors of our previous baseline study were assigned as community mobilizers. They provided counseling for the selected persons.

Data collection

The field epidemiological study was conducted from October 2015 to April 2016, mostly following the standard WHO STEPS procedures [6]. We used a modified questionnaire of 2010 Bangladesh STEPS [8], which consisted of all core questions and some expanded questions in the WHO prototype and additional questions such as types of tobacco. We also incorporated the findings of qualitative studies conducted between November 2014 and August 2015 [16] and added several questions such as those related to salt intakes. The questionnaire was pretested in adjacent shantytowns and revised several times until all interviewers became confident in completing the interviews.

The interviewers visited the selected household and interviewed the eligible person in Bengali language. Participants who completed the interview were invited to the study clinic in the National Heart Foundation Hospital and Research Institute for physical measurements and blood sampling. The Institute was close to the community and transport cost was provided when a participant showed up. Those who failed to show up were reminded and motivated by the community mobilizers.

Participants were asked about their medical histories and medications, then height, weight, waist and hip circumferences, and blood pressure were measured. Female nurses conducted the anthropometric measurement of women participants. The anthropometric measurements were taken in light clothing without shoes or other heavy accessories. After resting 15 minutes, blood pressure was measured three times in the right upper arm by using automatic digital sphygmomanometer (HEM-8712, OMRON Corporation, Japan). Systolic blood pressure

(SBP), diastolic blood pressure (DBP), and pulse per minute were recorded, and the arithmetic mean of the second and third readings of blood pressure was used for the analysis. In case of arrhythmia, blood pressure was measured twice by manual sphygmomanometer.

The poor people, who worked very early in the morning, could come to the study clinic only in the afternoon. Thus, random blood samples were taken to measure glucose, glycated hemoglobin (HbA1c), total, HDL- and LDL-cholesterol, triglycerides, and complete blood count. About 10 ml of venous blood was drawn and analyzed at the clinical laboratory of the National Heart Foundation Hospital and Research Institute, using calibrated automatic analyzers (Dimension RxL Max, Siemens, USA, for glucose, total, HDL- and LDL-cholesterol, triglycerides and HbA1c; and Hematology Analyzer Mythic 22, Orphee, Switzerland, for hemoglobin, red blood cell, white blood cell and platelet counts).

Data analysis

The participants' names were separated from the original sheets, which were coded with serial numbers. The anonymized data were entered in a programmed data entry template and the accuracy of the data entry was verified using 10% double-entry method. There were no missing variables in the present analyses except for one person's gender. We excluded the subject from the data analysis.

We categorized all continuous readings of physical and biochemical measurements according to well-defined standards. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, and then categorized into four groups: <18.5, 18.5–24.9, 25–29.9, and ≥30 kg/m^2 [17]. Hypertension was defined as SBP ≥140 mmHg, or DBP ≥90 mmHg, or use of any antihypertensive medication [18]. Random blood glucose levels were classified as: <140, 140-199, and ≥200 mg/dL; and HbA1c levels as: <5.7, 5.7–6.4, and ≥6.5% [19]. Blood lipid levels were classified by the following cutoff values: total cholesterol levels as <150, 150–189, 190–199, 200–239, ≥240 mg/dL; HDL-cholesterol levels as <40, 40–49, ≥50 mg/dL; LDL-cholesterol levels as <100, 100–129, 130–159, ≥160 mg/dL; triglyceride levels as <100, 100–149, 150–199 and ≥200 mg/dL [20, 21].

We presented sampling weight corrected prevalence or means for total men and women. Finite population correction was applied to the calculation of 95% confidence intervals. For variables with skewed distributions, log-transformed data were used. To test differences between men and women on each categorical data, chi-squared test was applied. Student's t-test was used for testing difference of means across gender. All of the statistical analyses were performed using the statistical software, Stata IC, Release 12 (StataCorp LP, College Station, TX, USA).

Ethical considerations

This study was approved by the Bioethics Review Committee of Nagoya University School of Medicine, Japan (approval no. 2014-0021). Institutional Review Boards of Bangabandhu Sheikh Mujib Medical University and National Heart Foundation Hospital and Research Institute, Bangladesh, approved the study as well. Written informed consent was obtained from all participants. Participants with no education provided fingerprints on the consent sheets after receiving sufficient verbal explanation.

RESULTS

In total, 2551 eligible persons participated in the questionnaire-based interview: 1289 (674 men and 615 women) were from the housing level 1 group and 1262 (684 men and 578 women) were from the housing level 2 group. Among the interview participants, 2009 persons (78.8%) participated in the physical and biochemical measurements, of whom 1002 (504 men and 498 women) were from the housing level 1 group and 1007 (504 men and 503 women) were from the housing level 2 group.

Table 1 shows demographic and behavioral characteristics. Mean age of the 2551 participants was 35.8 years in men and 35.6 years in women. Current tobacco users were 60.4% of men (54.6% in the housing level 1 and 64.2% in the housing level 2) and 23.5% of women (14.8% in the housing level 1 and 29.1% in the housing level 2). Tobacco smoking (cigarette, *beedi*, *etc.*) was reported only from men (53.0% in total, 48.7% in the housing level 1 and 55.8% in the housing level 2). Smokeless tobacco chewing was more common in women (23.5% in total, 14.8% in the housing level 1 and 29.1% in the housing level 2) than men (16.3% in total, 11.6% in the housing level 1 and 19.3% in the housing level 2). Alcohol drinking was reported only from men (3.2% in total, 4.6% in the housing level 1 and 2.3% in the housing level 2).

Most of them (92.9% of men and 88.7% of women) consumed at least 1 serving of fruits and vegetables per day, however, those who had more than 5 servings were only 0.9% of men and 3.3% of women. Those who had less than 1 serving were 7.1% of men (7.3% in the housing level 1 and 6.9 % in the housing level 2) and 11.3% of women (3.3% in the housing level 1 and 16.5% in the housing level 2). Only 20.9% of men and 21.0% of women reported that they never added table salt to their meals, while 55.9% of men and 51.2% of women always took additional salt. Prevalence of moderate or high level of total physical activity (≥600 MET-minutes per week) was 76.5% in men and 35.8% in women, which is comparable with the findings of the urban population of 2010 STEPS [22].

Comparing to the housing level 1 group, the housing level 2 group participants were less likely to: be educated, be employed, have fruits and vegetables; and add salt. They were more likely to be: day laborers; tobacco users; and physically active (P <0.05 for all, not shown in the Tables).

Table 2 shows the percentages of biological indicators classified by appropriate criteria, and Table 3 shows prevalence of biological NCD risk factors by gender and household wealth status. Overweight/obesity was more common in women (39.2%) than men (18.9%), while underweight was more common in men (21.0%) than women (7.1%). Overweight/obesity prevalence was higher than the estimated national prevalence of men (16.4%) and women (24.2%) [23].

According to WHO recommended cut-off points [24], prevalence of increased waist circumference (men >94 cm; women >80 cm) and increased waist-hip ratio (men ≥0.90; women ≥0.85) were 9.2% and 64.4% in men and 53.3% and 80.1% in women, respectively. Prevalence of increased waist circumference in men was 16.2%, according to the cut-off point for south Asian men (>90 cm) recommended by International Diabetes Federation [24].

The prevalence of hypertension was 18.6% in men and 20.7% in women, which was comparable with the findings of previous STEPS surveys [9-11].

Prevalence of diabetes (HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment) [19] was 15.6% in men (13.7% in the housing level 1 and 16.9% in the housing level 2) and 22.5% in women (20.7% in the housing level 1 and 23.7% in the housing level 2), much higher than the WHO estimated national prevalence (men 8.6%; women 7.4%) [23]. Only 4.5% of men and 5.4% of women showed diabetes level of random blood glucose, indicating unreliability of random blood glucose for screening diabetes.

Mean value of total cholesterol was 167 mg/dL in men and 174 mg/dL in women, and mean value of HDL-cholesterol was as low as 33 mg/dL in men and 38 mg/dL in women. The prevalence of raised total cholesterol (≥190 mg/dL or on medication) was 25.7% in men and 34.0% in women, respectively. High risk range of low level HDL-cholesterol (<40 mg/dL) [20] was 73.2% in men and 55.7% in women, and borderline-high/high level LDL-cholesterol (≥130 mg/dL) [20] was 11.7% in men and 12.6% in women. High level triglycerides (≥200 mg/dL) [20] was more common in men (32.2%) than women (22.4%).

Regarding the prevalence of physical and biochemical risk factors, such as overweight/obesity, hypertension, diabetes and dyslipidemia, significant difference was not found between the housing level 1 and the housing level 2 groups (not shown in Tables).

DISCUSSION

This study is the first comprehensive epidemiological survey of various NCD risk factors including HbA1c among the urban poor in Bangladesh, who are considered to be an underserved high risk population.

We found that overweight/obesity prevalence of both men and women was higher than the estimated national prevalence. Overweight/obesity prevalence in women was as high as 39.2%, which could be attributed to the sedentary lifestyle of urban women [25]. Overweight/obesity and underweight were equally prevalent in men, reflecting their socio-economic situation: many men still had to be involved in hard physical labor [26], while some men could afford to eat well. Our findings suggested that both overweight/obesity and underweight should be addressed simultaneously.

High prevalence of increased waist-hip ratio in both men and women and increased waist circumference in women indicated high risks of metabolic syndrome among the urban poor. However, it would require further studies to identify appropriate cut-off points and clinical implications of BMI, waist circumference, and waist-hip ratio in Bangladesh, considering the discrepancy between waist circumference and waist-hip ratio in men.

The prevalence of diabetes in both housing levels and in both genders were much higher than the WHO estimated national prevalence [23], and the findings of the 2006 STEPS survey (men 7.6%; women 2.8%) [10]. The findings of our study were in line with the increasing trend reported elsewhere [23], therefore, diabetes prevalence may have increased since the last surveys. Diabetes prevalence of the poor may be higher than the national average, indicating an association of low socio-economic status and increased diabetes prevalence, as studies in high income countries showed [27, 28]. The higher diabetes prevalence among the urban poor may be attributed to childhood undernutrition, but further investigation is required.

Diabetes prevalence was higher in women than men, contrary to the findings of the 2006 survey. The urban poor women may be more prone to diabetes than men, since gender difference in diabetes prevalence may vary depending on socio-economic situations [29]. However, the higher HbA1c level in women than men might have been due to higher prevalence of anemia (hemoglobin <11 mg/dL) [30] in women (14.8%) than men (1.8%), which was reported to shift HbA1c values toward higher ends [31-34]. In our study, we used the WHO recommended HbA1c cut-off point [35], but caution is needed in light of the high anemia prevalence. Further studies are required to fully understand and interpret HbA1c values in low and lower-middle income countries.

Our study is the first population-based survey of blood lipid profile of the urban poor in Bangladesh. High risk range of low HDL-cholesterol was highly prevalent, but desirable range of low total cholesterol and LDL-cholesterol were both highly prevalent as well. The findings were consistent with the findings of a previous study of a rural population, although desirable range of low LDL-cholesterol was more prevalent in our study than that in the previous one [12]. Clinical implications of low levels of HDL- and LDL-cholesterol of this population need to be investigated further. Relatively high prevalence of high level triglycerides might be overestimated, as random blood samples were used.

High prevalence of tobacco use was confirmed in this study. This is consistent with previous studies [36, 37]. Chewing tobacco products seemed to be culturally tolerated, as shown that women often chewed tobacco but refrained smoking tobacco. Different approaches for men and women need to be developed for controlling tobacco.

About 80% of the participants added table salt to their meals, although the meals were cooked and seasoned with salt. Further studies are needed to determine the amount of salt intake of this population, as we did not measure total salt intake. Our qualitative study found that people in the community sprinkled table salt on rice because they liked salty taste and served salt with meal for welcoming guests [16]. While salt reduction is known to be a cost effective strategy to prevent cardiovascular diseases [38, 39], modifying dietary habit of individuals in a short time would be very difficult. Thus, a long term community wide campaign to modify diet is required, as shown in successful examples in Japan [40, 41].

The strength of this study is that we targeted the urban poor, an underserved high risk population, using representative sampling methods. Analyzing blood samples by high-performance automatic equipment in a reliable clinical laboratory, but not by portable devices often used by STEPS surveys, enabled us to measure low levels of glucose and total cholesterol, as well as HDL- and LDL-cholesterol, triglycerides, HbA1c and complete blood count. However, this study has several limitations. First, we targeted only one urban poor community, which may not represent nationwide situation. Second, we could not measure fasting blood samples. While random blood glucose value was unreliable for screening diabetes, we found measuring HbA1c could be a useful alternative.

In conclusion, the current survey revealed high prevalence of NCD risk factors among the urban poor in Bangladesh. Diabetes, dyslipidemia, hypertension, tobacco use, and both overweight and underweight were prevalent, indicating the dual burden among the urban poor. Our findings can serve as baseline epidemiological data and help policymakers develop appropriate NCD control strategies.

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Contributors A.A., M.K., S.R.C., H.Y., and A.M. designed the study, M.K., S.R.C., M.A.A., B.A.H. and S.S.I. conducted the field survey and data collection, C.C., M.K., H.Y., S.R.C., and A.A. statistically analyzed and interpreted the data, A.A., M.K., C.C., and A.A.A.A. drafted the manuscript, H.Y., S.R.C., H.I., S.S.I., A.M., and Y.H. provided critical inputs on the draft. All authors approved the final draft.

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Table 1. Demographic and behavioral characteristics of participants by gender and household wealth status

	Men			Women			*p* for gender difference [b]
Household wealth status	Housing level 1	Housing level 2	All [a]	Housing level 1	Housing level 2	All [a]	
Number	674	684	1358	615	578	1193	
Age group of years (%)							0.920
18-24	19.4	14.9	16.7	17.7	16.1	16.7	
25-34	35.0	32.9	33.7	37.1	31.0	33.4	
35-44	26.6	25.6	26.0	24.7	28.9	27.3	
45-54	13.9	15.9	15.2	13.7	14.9	14.4	
55-64	5.0	10.7	8.5	6.8	9.2	8.2	
mean (95% CI) [c]	34.4 (33.7-35.0)	36.8 (36.0-37.5)	35.8 (35.3-36.3)	34.3 (33.6-35.0)	36.4 (35.6-37.2)	35.6 (35.0-36.1)	0.549
Years of education (%)							<0.001
none	22.0	32.6	28.4	31.5	45.0	39.7	
1-4	10.5	17.4	14.7	15.9	23.0	20.2	
5-7	24.5	19.6	21.5	29.6	18.3	22.8	
8-9	20.7	16.5	18.1	13.2	8.5	10.3	
≥10	22.3	13.9	17.2	9.8	5.2	7.0	
Religion (%)							0.365
Islam	98.7	96.3	97.3	98.9	97.1	97.8	
Hinduism	1.3	3.7	2.7	1.1	2.9	2.2	
Marital status (%)							<0.001
unmarried	15.4	13.6	14.3	0.7	1.4	1.1	
married	84.6	85.8	85.3	90.2	85.3	87.2	
others	0.0	0.6	0.4	9.1	13.3	11.7	
Occupation (%)							<0.001
employed	22.8	13.6	17.2	17.4	14.0	15.3	
self-employed	44.2	43.1	43.6	3.6	13.3	9.5	
day labor	23.7	30.0	27.5	2.0	7.1	5.1	
homemaker	0.3	0.1	0.2	75.8	64.4	68.8	
others	8.9	13.2	11.5	1.3	1.2	1.2	
Any form of tobacco (%)							<0.001
non-user	39.3	30.8	34.2	84.2	68.2	74.5	

ex-user	6.1	5.0	5.4	1.0	2.8	2.1	
current user	54.6	64.2	60.4	14.8	29.1	23.5	
Tobacco smoking (%)							<0.001
non-smoker	43.6	38.7	40.7	99.5	98.1	98.7	
ex-smoker	7.7	5.4	6.3	0.5	1.9	1.3	
current smoker	48.7	55.8	53.0	0.0	0.0	0.0	
Smokeless tobacco chewing (%)							<0.001
non-user	87.8	78.4	82.1	84.6	68.9	75.0	
ex-user	0.6	2.3	1.7	0.7	2.1	1.5	
current user	11.6	19.3	16.3	14.8	29.1	23.5	
Alcohol drinking (%)							<0.001
non-drinker	95.4	97.7	96.8	100.0	100.0	100.0	
current drinker	4.6	2.3	3.2	0.0	0.0	0.0	
Fruit/vegetable intake, servings per day (%)							<0.001
<1	7.3	6.9	7.1	3.3	16.5	11.3	
1-2.9	61.7	67.1	65.0	57.2	72.6	66.6	
3-4.9	31.0	24.5	27.1	31.7	10.6	18.9	
≥5	0.0	1.5	0.9	7.8	0.3	3.3	
Adding salt at the table (%)							<0.001
always	70.2	46.6	55.9	67.0	41.0	51.2	
often	5.9	13.3	10.4	1.6	28.5	18.0	
sometimes	5.8	17.4	12.8	10.7	9.2	9.8	
never	18.1	22.7	20.9	20.7	21.3	21.0	
Total physical activity, MET-minutes per week (%)							<0.001
<600	30.4	19.0	23.5	83.9	51.4	64.2	
600-2999	38.3	26.9	31.4	14.8	44.5	32.8	
≥3000	31.3	54.1	45.1	1.3	4.2	3.0	

Abbreviation: CI, confidence interval of mean; MET, metabolic equivalent
[a] Weighted based on the sampling design.
[b] Gender differences between all men and all women were tested by chi-squared test and t-test as appropriate.
[c] Finite population correction was applied to the calculation of 95% CI for mean age.

Table 2. Physical and biochemical characteristics of participants by gender and household wealth status

	Men			Women			*p* for gender difference [b]
Household wealth status	Housing level 1	Housing level 2	All [a]	Housing level 1	Housing level 2	All [a]	
Number	504	504	1008	498	503	1001	
Body mass index, kg/m^2 (%)							<0.001
<18.5	18.5	22.6	21.0	7.2	7.0	7.1	
18.5-24.9	60.3	59.9	60.1	53.4	53.9	53.7	
25-29.9	19.2	15.9	17.2	30.9	29.4	30.0	
≥30	2.0	1.6	1.7	8.4	9.7	9.2	
mean (95% CI) [c]	21.9 (14.1-29.7)	21.6 (15.1-28.0)	21.7 (14.7-28.8)	24.2 (14.4-33.9)	24.1 (16.3-31.9)	24.1 (15.5-32.7)	<0.001
Waist circumference, cm (%)							<0.001
≤80	53.8	56.0	55.1	47.0	46.5	46.7	
81-90	29.6	28.2	28.7	29.5	34.2	32.4	
91-94	7.5	6.5	6.9	9.0	7.8	8.2	
>94	9.1	9.3	9.2	14.5	11.5	12.6	
mean (95% CI) [c]	80.2 (58.2-102.1)	79.6 (61.2-98.0)	79.8 (59.9-99.8)	82.2 (55.2-109.2)	81.9 (62.5-101.4)	82.0 (59.7-104.4)	<0.001
Waist-hip ratio (%)							<0.001
<0.8	2.6	4.2	3.5	5.4	5.8	5.6	
0.8-0.84	11.3	9.5	10.2	13.9	14.5	14.3	
0.85-0.89	24.0	20.4	21.8	22.9	27.5	25.8	
≥0.9	62.1	65.9	64.4	57.8	52.2	54.3	
mean (95% CI) [c]	0.92 (0.78-1.06)	0.93 (0.81-1.05)	0.93 (0.80-1.05)	0.91 (0.75-1.07)	0.90 (0.78-1.03)	0.91 (0.77-1.04)	<0.001
Systolic blood pressure, mmHg (%)							<0.001
<120	55.6	56.9	56.4	67.9	65.4	66.3	
120-129	23.2	18.5	20.3	14.7	14.9	14.8	
130-139	10.7	11.9	11.4	7.8	8.2	8.0	
≥140	10.5	12.7	11.8	9.6	11.5	10.8	
mean (95% CI) [c]	120 (87-152)	121 (89-153)	121 (88-153)	115 (73-158)	116 (83-149)	116 (79-153)	<0.001
Diastolic blood pressure, mmHg (%)							0.475
<80	58.9	59.7	59.4	60.6	63.2	62.3	
80-84	15.9	14.1	14.8	14.1	13.1	13.5	

85-89	11.5	11.5	11.5	10.0	10.5	10.3	
≥90	13.7	14.7	14.3	15.3	13.1	13.9	
mean (95% CI) [c]	78 (55-101)	79 (58-99)	78 (57-100)	78 (51-105)	78 (58-98)	78 (55-101)	0.197
HbA1c, % (%)							<0.001
<5.7	51.4	48.8	49.8	49.6	46.3	47.6	
5.7-6.4	35.1	34.5	34.8	31.1	30.6	30.8	
≥6.5	13.5	16.7	15.4	19.3	23.1	21.6	
mean (95% CI) [cd]	5.8 (4.4-7.6)	5.8 (4.2-8.1)	5.8 (4.3-7.8)	5.9 (4.1-8.4)	6.0 (4.1-8.6)	5.9 (4.1-8.6)	0.004
Random blood glucose, mg/dL (%)							0.261
<140	93.3	91.3	92.0	89.2	90.9	90.0	
140-199	3.6	3.4	3.5	5.6	3.6	4.3	
≥200	3.2	5.4	4.5	5.2	5.6	5.4	
mean (95% CI) [cd]	98 (55-175)	101 (52-196)	100 (55-183)	102 (54-196)	102 (55-189)	102 (53-197)	0.123
Total cholesterol, mg/dL (%)							<0.001
<150	36.1	36.5	36.4	27.7	30.2	29.3	
150-189	40.1	37.7	38.6	37.1	38.2	37.8	
190-199	4.4	6.9	5.9	8.6	8.3	8.5	
200-239	15.1	14.7	14.8	19.9	17.7	18.5	
≥240	4.4	4.2	4.2	6.6	5.6	6.0	
mean (95% CI) [c]	166 (85-248)	167 (101-232)	167 (94-239)	176 (82-270)	173 (96-249)	174 (90-258)	<0.001
HDL-cholesterol, mg/dL (%)							<0.001
<40	73.8	72.8	73.2	57.1	54.9	55.7	
40-49	20.4	19.2	19.7	27.2	27.4	27.3	
≥50	5.8	7.9	7.1	15.7	17.7	16.9	
mean (95% CI) [cd]	33 (19-57)	33 (19-57)	33 (20-56)	38 (19-65)	38 (22-67)	38 (22-68)	<0.001
LDL-cholesterol, mg/dL (%)							0.830
<100	54.3	58.3	56.7	51.4	57.4	55.1	
100-129	34.2	30.0	31.6	34.5	31.1	32.4	
130-159	9.5	9.3	9.4	11.0	9.8	10.2	
≥160	2.0	2.4	2.2	3.0	1.8	2.3	
mean (95% CI) [c]	98 (39-156)	96 (49-143)	97 (45-149)	101 (35-167)	98 (40-156)	99 (37-161)	0.063
Triglycerides, mg/dL (%)							<0.001

<100	24.6	30.2	28.0	36.7	36.0	36.3	
100-149	25.0	22.8	23.7	25.5	24.7	25.0	
150-199	19.4	14.1	16.2	15.5	16.9	16.4	
≥200	31.0	32.9	32.2	22.3	22.5	22.4	
mean (95% CI) [cd]	150 (48-473)	151 (42-539)	151 (46-489)	125 (41-379)	128 (38-432)	127 (37-432)	<0.001
Hemoglobin, mg/dL (%)							<0.001
<11	1.6	2.0	1.8	13.9	15.3	14.8	
11-11.9	3.6	3.6	3.6	25.3	29.0	27.6	
12-12.9	6.2	9.5	8.2	39.0	33.2	35.4	
13-16.9	88.1	84.1	85.7	21.9	22.5	22.2	
≥17	0.6	0.8	0.7	0.0	0.0	0.0	
mean (95% CI) [c]	14.3 (11.5-17.0)	14.2 (11.8-16.6)	14.2 (11.6-16.8)	12.1 (9.3-14.9)	12.0 (9.7-14.3)	12.0 (9.5-14.6)	<0.001

Abbreviation: CI, confidence interval; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Weighted based on the sampling design.

[b] Gender differences between all men and all women were tested by chi-squared test or t-test as appropriate.

[c] Finite population correction was applied to the calculation of 95% CI.

d Log-transformed data were used

Table 3 Prevalence of physical and biochemical risk factors of non-communicable diseases by gender and household wealth status, % (95% CI) [a]

Household wealth status	Men: Housing level 1	Men: Housing level 2	Men: All [b]	Women: Housing level 1	Women: Housing level 2	Women: All [b]	*p* for gender difference [c]
Overweight or obesity BMI ≥25 kg/m^2	21.2 (18.3-24.2)	17.5 (14.5-20.4)	18.9 (16.8-21.1)	39.4 (36.0-42.7)	39.2 (35.4-42.9)	39.2 (36.6-41.9)	<0.001
Obesity BMI ≥30 kg/m^2	2.0 (1.0-3.0)	1.6 (0.6-2.6)	1.7 (1.0-2.5)	8.4 (6.5-10.3)	9.7 (7.4-12.0)	9.2 (7.7-10.8)	<0.001
Large waist circumference							
men >90 cm, women >80 cm	16.7 (14.0-19.4)	15.9 (13.0-18.7)	16.2 (14.2-18.2)	53.0 (49.6-56.4)	53.5 (49.7-57.3)	53.3 (50.6-56.0)	<0.001
men >94 cm, women >80 cm	9.1 (7.0-11.2)	9.3 (7.1-11.6)	9.2 (7.6-10.8)	53.0 (49.6-56.4)	53.5 (49.7-57.3)	53.3 (50.6-56.0)	<0.001
Large waist-hip ratio men ≥0.9, women ≥0.85	62.1 (58.6-65.6)	65.9 (62.2-69.6)	64.4 (61.8-67.0)	80.7 (78.0-83.4)	79.7 (76.6-82.8)	80.1 (77.9-82.2)	<0.001
Hypertension							
SBP ≥140 mmHg or DBP ≥90 mmHg	16.9 (14.2-19.6)	18.1 (15.1-21.1)	17.6 (15.5-19.7)	16.5 (13.9-19.0)	16.7 (13.8-19.6)	16.6 (14.6-18.6)	0.512
SBP ≥140 mmHg or DBP ≥90 mmHg or on medication	18.3 (15.5-21.0)	18.8 (15.8-21.9)	18.6 (16.5-20.8)	20.3 (17.5-23.0)	20.9 (17.8-24.0)	20.7 (18.5-22.9)	0.195
Diabetes: HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or on diabetes treatment.	13.7 (11.2-16.2)	16.9 (13.9-19.8)	15.6 (13.6-17.6)	20.7 (17.9-23.5)	23.7 (20.4-26.9)	22.5 (20.3-24.8)	<0.001
Raised total cholesterol							
≥190 mg/dL	23.8 (20.7-26.9)	25.8 (22.4-29.2)	25.0 (22.6-27.4)	35.1 (31.9-38.4)	31.6 (28.1-35.2)	32.9 (30.4-35.5)	<0.001
≥190 mg/dL or on medication	24.4	26.6	25.7	35.9	32.8	34.0	0.001

	(21.3-27.5)	(23.1-30.0)	(23.3-28.1)	(32.6-39.2)	(29.2-36.4)	(31.4-36.5)	
Low HDL-cholesterol							
both men and women <40 mg/dL	73.8 (70.6-77.0)	72.8 (69.4-76.3)	73.2 (70.8-75.7)	57.1 (53.7-60.6)	54.9 (51.1-58.7)	55.7 (53.0-58.4)	<0.001
men <40 mg/dL, women <50 mg/dL	73.8 (70.6-77.0)	72.8 (69.4-76.3)	73.2 (70.8-75.7)	84.1 (81.6-86.6)	82.3 (79.4-85.2)	83.0 (80.9-85.0)	<0.001
Raised LDL-cholesterol ≥130 mg/dL	11.7 (9.4-14.0)	11.7 (9.2-14.2)	11.7 (9.9-13.5)	14.1 (11.7-16.4)	11.7 (9.3-14.2)	12.6 (10.8-14.4)	0.484
Raised triglycerides ≥150 mg/dL	50.4 (46.8-54.0)	47.0 (43.1-50.9)	48.4 (45.6-51.1)	37.8 (34.4-41.1)	39.4 (35.6-43.1)	38.8 (36.1-41.4)	<0.001

Abbreviation: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Finite population correction was applied to the calculation of 95% CI for each proportion.

[b] Weighted based on the sampling design

[c] Gender differences between all men and all women were tested by chi-squared test.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5–6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6–10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6–10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6–8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9–10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9–10
Bias	9	Describe any efforts to address potential sources of bias	8–11
Study size	10	Explain how the study size was arrived at	6–8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10–11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7–8, 10–11
		(*b*) Describe any methods used to examine subgroups and interactions	10–11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7–8, 10–11
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7–8, 11
		(b) Give reasons for non-participation at each stage	7–9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11–12 23–24
		(b) Indicate number of participants with missing data for each variable of interest	10–11
Outcome data	15*	Report numbers of outcome events or summary measures	11–13

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	10, 25–29
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	3, 4, 13–14, 16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4, 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14–16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

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Prevalence of non-communicable disease risk factors among poor shantytown residents in Dhaka, Bangladesh: a community-based cross-sectional survey

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Prevalence of non-communicable disease risk factors among poor shantytown residents in Dhaka, Bangladesh: a community-based cross-sectional survey

Md. Khalequzzaman[1], Chifa Chiang[2], Sohel Reza Choudhury[3], Hiroshi Yatsuya[2, 4], Mohammad Abdullah Al-Mamun[3], Abubakr Ahmed Abdullah Al-Shoaibi[2], Yoshihisa Hirakawa[2], Bilqis Amin Hoque[5], Syed Shariful Islam[1], Akiko Matsuyama[2, 6], Hiroyasu Iso[7], and Atsuko Aoyama[2*]

[1] Department of Public Health and Informatics, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

[2] Department of Public Health and Health Systems, Nagoya University School of Medicine, Nagoya, Japan

[3] Department of Epidemiology and Research, National Heart Foundation Hospital and Research Institute, Dhaka, Bangladesh

[4] Department of Public Health, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

[5] Environment and Population Research Center, Dhaka, Bangladesh

[6] Nagasaki University School of Tropical Medicine and Global Health, Nagasaki, Japan

[7] Public Health Graduate School of Medicine, Osaka University, Suita, Osaka, Japan

*Corresponding author: Atsuko Aoyama, MD, PhD

Department of Public Health and Health Systems, Nagoya University School of Medicine

65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan

e-mail: atsukoa@med.nagoya-u.ac.jp telephone: +81-52-744-2108

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ABSTRACT

Objectives: This study aims to describe the prevalence of non-communicable disease (NCD) risk factors among the urban poor in Bangladesh.

Design: We conducted a community based cross-sectional epidemiological study.

Setting: The study was conducted in a shantytown in the city of Dhaka. There were 8604 households with 34 170 residents in the community. Those households were categorized into two wealth strata based on the housing structure.

Participants: The study targeted 18-64-year-old residents. A total of 2986 eligible households with one eligible individual were selected by simple random sampling stratified by household wealth status. A total of 2551 residents completed the questionnaire survey, and 2009 participated in the subsequent physical and biochemical measurements.

Outcome measures: A modified WHO survey instrument was used for assessing behavioural risk factors and physical and biochemical measurements, including glycated haemoglobin (HbA1c). The prevalence of NCD risk factors, such as tobacco use, fruit and vegetable intake, overweight/obesity, hypertension, diabetes (HbA1c ≥6.5%), and dyslipidaemia, was described according to household wealth status and gender differences.

Results: The prevalence of current tobacco use was 60.4% in men and 23.5% in women. Most of them (90.8%) consumed more than 1 serving of fruits and vegetables per day; however, only 2.1% consumed more than 5 servings. Overweight/obesity was more common in women (39.2%) than in men (18.9%), while underweight was more common in men (21.0%) than in women (7.1%). The prevalence of hypertension was 18.6% in men and 20.7% in women. The prevalence of diabetes was 15.6% in men and 22.5% in women, which was much higher than the estimated national prevalence (7%). The prevalence of raised total cholesterol (≥190 mg/dL) was 25.7% in men and 34.0% in women.

Conclusions: The study identified that tobacco use, both overweight and underweight,

diabetes, hypertension, and dyslipidaemia were prevalent among the urban poor in Bangladesh.

Strengths and limitations of this study:

- This study is the first population-based survey that includes the measurement of glycated haemoglobin (HbA1c) and blood lipid profiles in an urban setting of Bangladesh.
- This study targeted the urban poor, an underserved high-risk population, using representative sampling methods.
- By analysing blood samples using high-performance automatic equipment in a reliable clinical laboratory rather than using portable devices often used for STEPS surveys, we were able to measure low levels of glucose and total cholesterol, as well as HDL and LDL cholesterol, triglycerides, HbA1c and complete blood count.
- This study targeted only one urban poor community, which may not represent the nationwide situation.
- We could not measure fasting blood samples, but we used HbA1c as a viable alternative.

INTRODUCTION

Non-communicable diseases (NCDs) are globally recognized threats; thus, reducing the burden of NCDs has been included as one of the targets of the Sustainable Development Goals [1]. NCDs are new priorities and additional burdens on health in low- and middle-income countries, where urbanization and lifestyle changes are advancing rapidly. In addition, low birth weight and childhood malnutrition among the poor may increase the risks of cardiovascular diseases and diabetes in adulthood [2, 3].

Bangladesh is a lower-middle-income country in South Asia with a population of over 160 million in 2015 [4]. While infectious diseases are still prevalent, the burden of NCDs is also increasing, even among the poor [5]. Population-based NCD risk factor surveys using a standardized method from the World Health Organization (WHO) called the STEPwise approach to surveillance (STEPS) [6] had been conducted four times in the past in Bangladesh [7-11]. The WHO STEPS approach is a simple, standardized and flexible method that any country can implement to monitor NCD risk factors. This method also allows for comparison across countries. The STEPS instrument includes the following: Step 1) questionnaire-based assessment of behavioural risk factors, such as tobacco use, alcohol consumption, diet and physical activity; Step 2) physical measurements of weight, height, waist and hip circumferences, and blood pressure; and Step 3) biochemical measurements of fasting blood glucose and blood lipids, such as total cholesterol. The STEPS surveys of 2002, 2010, and 2013 implemented only Steps 1 and 2. The 2006 survey also conducted Step 3, with measurement of blood glucose and total cholesterol. The 2013 STEPS reported the prevalence of overweight/obesity as 25.7% (urban 29%, rural 23%), hypertension as 21.4% (urban 27%, rural 18%), and tobacco use as 43.9% (urban 45%, rural 43%) [9]. The 2006 STEPS reported the prevalence of diabetes as 5.5% and the prevalence of raised total cholesterol as 6.9% [10]. Another population-based survey on blood lipid profile, including high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol and triglycerides, was conducted in 2001, targeting fewer than 500 rural residents [12].

The urban population is rapidly increasing, as indicated by 3.4% annual urban population growth in comparison to 1.2% in the whole nation [4]. Along with the population growth of the urban poor, the burden of NCDs is increasing due to lifestyle changes and possible childhood undernutrition. However, the situation surrounding NCDs and their risk factors among the urban poor is largely unknown, and very little data on the prevalence of NCD risk factors are available.

We conducted a cross-sectional epidemiological study on NCD risk factors by applying a modified WHO STEPS procedure and a qualitative study on perceptions and attitudes towards NCD risk factors, targeting residents in an urban poor community in Bangladesh. This paper aims to describe the prevalence of NCD risk factors among the urban poor in Dhaka, Bangladesh.

METHODS

Study site and study population

We conducted the study in Bauniabadh, an urban poor community in Dhaka, Bangladesh [13]. The community was originally established by the government in 1972 as a settlement for the poor. An equal-size land plot was allocated to each household at an affordable price. Since then, many residents have moved in or out without registration, and the community expanded with sprawling shantytowns outside the original boundary. Although the original residents were equally poor, some of the current residents have become relatively well off by buying up several plots to build brick houses, while others have remained very poor, sharing shanties made of bamboo and tin.

We defined the target population of this study as adults between 18 and 64 years of age

who lived within the original boundary of Bauniabadh. Since accurate census data were not available, we conducted a census-like baseline survey targeting all households within the original boundary between August and November 2014. Individuals or family members who made common provision of food and resided under the same roof were regarded as members of the same household. We identified 8604 households with 34 170 residents, among whom 21 050 were adults between 18 and 64 years of age. The details of the household survey were described elsewhere [14].

While all dwellers of the shantytown were recognized as the urban poor, the findings of the baseline survey indicated that household wealth status somewhat varied among the dwellers. We categorized household wealth status into two groups: "housing level 1" households were defined as those living in single- or multi-storied houses with concrete roofs, concrete floors, and brick walls; "housing level 2" households were defined as those living in houses with tin roofs, mud or wooden floors, and brick, thatch, or bamboo walls. Housing level 1 households usually had their own kitchens and toilets, while several housing level 2 households shared a kitchen and a toilet. The baseline survey data showed that 39% of the population in the community belonged to the housing level 1 group, while 61% belonged to the housing level 2 group. There was no gender difference between the two groups.

Sampling

We applied a simple random sampling procedure stratified according to gender and household wealth status. Target sample size was calculated using the mean and standard deviation of BMI (20.9 and 4.2, respectively, in men) from the 2010 STEPS Survey [11]. We set the difference in the mean BMI between housing level groups to be 1.0 and type I and II errors to be 0.05 and 0.2, respectively. Although the necessary sample size was calculated to be approximately 300, we decided to sample 500 individuals in each housing level and gender stratum to obtain enough statistical power (at least 2000 subjects in total). Since only one person was sampled from each household, we randomly selected 1000 households for men and 1000 households for women in each housing level group at the outset of the study. In total, 4000 households were selected, given the possibility that an eligible person may be unavailable in the assigned household or decline participation, as suggested by the STEPS survey guideline (80% response rate) [6]. We recruited one adult aged 18-64 years from each selected household using the Kish grid [15] until the total number of recruited subjects in each stratum surpassed 500. Pregnant women were excluded. We visited 3560 out of 4000 selected households as the number of individuals with complete data reached 2000. Specifically, among the 3560 selected households, 576 households were found ineligible due to the absence of any eligible persons. Out of 2986 eligible households with one eligible person, 435 selected individuals declined or were unavailable. Finally, 2551 subjects completed an interview conducted in their home (interview response rate: 85.4%), and 2009 subjects came to a study clinic in the National Heart Foundation Hospital and Research Institute to complete physical and biochemical measurements (response rate: 67.3%).

Staff training and community mobilization

Four men and two women who had obtained a college degree and had experience conducting field research were recruited as interviewers and trained on interview skills for five days. Two supervisors managed field activities and monitored data quality. Nurses and laboratory technicians of the National Heart Foundation Hospital and Research Institute were trained to conduct standard physical measurements following WHO guidelines.

To encourage people to participate in the survey, meetings with community leaders and other representatives were held in the community several times before and during the survey period. Community leaders were actively involved in motivating people to participate.

Community women who worked as surveyors for our previous baseline study were assigned as community mobilizers. They provided counselling for the selected individuals.

Data collection

The field epidemiological study was conducted from October 2015 to April 2016, mostly following the standard WHO STEPS procedures [6]. We used a modified questionnaire from the 2010 Bangladesh STEPS [8], which consisted of all core questions and some expanded questions in the WHO prototype, as well as additional questions such as types of tobacco used. We also incorporated the findings of qualitative studies conducted between November 2014 and August 2015 [16] and added several questions, such as those related to salt intake. The questionnaire was pretested in adjacent shantytowns and revised several times until all interviewers became confident in completing the interviews.

The interviewers visited the selected household and interviewed the eligible person in the Bengali language. Participants who completed the interview were invited to the study clinic in the National Heart Foundation Hospital and Research Institute for physical measurements and blood sampling. The institute was close to the community, and the cost of transport was provided to participants when they arrived. Those who failed to appear were reminded and motivated by the community mobilizers.

Participants were asked about their medical histories and medications. Afterwards, their height, weight, waist and hip circumferences, and blood pressure were measured. Female nurses conducted the anthropometric measurements of female participants. The anthropometric measurements were taken in light clothing without shoes or other heavy accessories. After resting for 15 minutes, blood pressure was measured three times in the right upper arm by using an automatic digital sphygmomanometer (HEM-8712, OMRON Corporation, Japan). Systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse per minute were recorded, and the arithmetic mean of the second and third readings of blood pressure was used for the analysis. In cases of arrhythmia, blood pressure was measured twice using a manual sphygmomanometer.

The poor study participants, who worked very early in the morning, could come to the study clinic only in the afternoon. Thus, random blood samples were taken to measure glucose; glycated haemoglobin (HbA1c); total, HDL and LDL cholesterol; triglycerides; and complete blood count. Approximately 10 ml of venous blood was drawn and analysed at the clinical laboratory of the National Heart Foundation Hospital and Research Institute using calibrated automatic analysers (Dimension RxL Max, Siemens, USA, for glucose; total, HDL and LDL cholesterol; triglycerides and HbA1c; and Hematology Analyzer Mythic 22, Orphee, Switzerland, for haemoglobin, red blood cell, white blood cell and platelet counts).

Data analysis

The participants' names were separated from the original sheets, which were coded with serial numbers. The anonymized data were entered into a programmed data entry template, and the accuracy of the data entry was verified using a 10% double-entry method. There were no missing variables in the present analyses except for one person's gender. We excluded this subject from the data analysis.

We categorized all continuous readings of physical and biochemical measurements according to well-defined standards (with some modification). Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared and then categorized into four groups: <18.5, 18.5–24.9, 25–29.9, and ≥30 kg/m^2 [17]. Hypertension was defined as SBP ≥140 mmHg, DBP ≥90 mmHg, or the use of any antihypertensive medication [18]. Random blood glucose levels were classified as follows: <140, 140-199, and ≥200 mg/dL. HbA1c levels were classified as follows: <5.7, 5.7–6.4, and ≥6.5% [19]. Blood lipid levels were classified by the following cut-off values: total cholesterol levels as <150, 150–189, 190–199, 200–239, and ≥240 mg/dL; HDL cholesterol levels as <40, 40–49, and ≥50 mg/dL; LDL cholesterol levels as <100, 100–129, 130–159, and ≥160 mg/dL; and triglyceride levels as <100, 100–149, 150–199 and ≥200 mg/dL [20, 21]. (The meaning of each category of the indicators are shown in Supplementary Note.)

Analyses adjusted for the complex survey design with four strata by the housing level and gender were conducted. To deal with unequal probabilities of selection, we presented sampling weight-corrected prevalence or means for total men and women. Since the survey was done in a single community, the finite population correction was applied to the calculation of unbiased 95% confidence intervals. For variables with skewed distributions, log-transformed data were used. To test the differences between men and women for each categorical data variable, the chi-squared test was applied. Student's t-test was used for testing mean differences between genders. All statistical analyses were performed using the statistical software Stata IC, Release 12 (StataCorp LP, College Station, TX, USA).

Ethical considerations

This study was approved by the Bioethics Review Committee of Nagoya University School of Medicine, Japan (approval no. 2014-0021). The Institutional Review Boards of Bangabandhu Sheikh Mujib Medical University and National Heart Foundation Hospital and Research Institute, Bangladesh, also approved the study. Written informed consent was obtained from all participants. Participants with no education provided fingerprints on the consent sheets after receiving sufficient verbal explanation.

RESULTS

In total, 2551 eligible persons participated in the questionnaire-based interview: 1289 (674 men and 615 women) were from the housing level 1 group, and 1262 (684 men and 578 women) were from the housing level 2 group. Among the interview participants, 2009 individuals (78.8%) participated in the physical and biochemical measurements, with 1002 (504 men and 498 women) from the housing level 1 group and 1007 (504 men and 503 women) from the housing level 2 group.

Table 1 shows the demographic and behavioural characteristics of the sample. The mean age of the 2551 participants was 35.8 years for men and 35.6 years for women. Current tobacco users were 60.4% of men (54.6% in housing level 1 and 64.2% in housing level 2) and 23.5% of women (14.8% in housing level 1 and 29.1% in housing level 2). Tobacco smoking (cigarette, *beedi*, *etc.*) was reported only by men (53.0% in total, 48.7% in housing level 1 and 55.8% in housing level 2). Smokeless tobacco chewing was more common among women (23.5% in total, 14.8% in housing level 1 and 29.1% in housing level 2) than men (16.3% in total, 11.6% in housing level 1 and 19.3% in housing level 2). Alcohol use was reported only by men (3.2% in total, 4.6% in housing level 1 and 2.3% in housing level 2).

Most of the participants (92.9% of men and 88.7% of women) consumed at least 1 serving of fruits and vegetables per day; however, only 0.9% of men and 3.3% of women consumed more than 5 servings. Among those who had less than 1 serving were 7.1% of men (7.3% in housing level 1 and 6.9% in housing level 2) and 11.3% of women (3.3% in housing level 1 and 16.5% in housing level 2). Only 20.9% of men and 21.0% of women reported that they never added table salt to their meals, while 55.9% of men and 51.2% of women always added salt. The prevalence of moderate or high levels of total physical activity (≥600 MET minutes per week) was 76.5% in men and 35.8% in women, which is comparable to the findings for the urban population of the 2010 STEPS [22].

Comparing to the housing level 1 group, the housing level 2 group participants were less likely to be educated, be employed, eat fruits and vegetables, and add salt. They were more likely to be day labourers, tobacco users, and physically active individuals (P <0.05 for all, not shown in the tables).

Table 2 shows the percentages of biological indicators classified by appropriate criteria, and Table 3 shows the prevalence of biological NCD risk factors by gender and household wealth status. Overweight/obesity was more common in women (39.2%) than men (18.9%), while underweight was more common in men (21.0%) than women (7.1%). Overweight/obesity prevalence was higher than the estimated national prevalence for men (16.4%) and women (24.2%) [23].

According to WHO-recommended cut-off points [24], the prevalence of increased waist circumference (men >94 cm; women >80 cm) and increased waist-hip ratio (men ≥0.90; women ≥0.85) were 9.2% and 64.4% in men and 53.3% and 80.1% in women, respectively. The prevalence of increased waist circumference in men was 16.2% according to the cut-off point for South Asian men (>90 cm) recommended by the International Diabetes Federation [24].

The prevalence of hypertension was 18.6% in men and 20.7% in women, which was comparable with the findings of previous STEPS surveys [9-11].

The prevalence of diabetes (HbA1c ≥6.5%, random blood glucose ≥200 mg/dL, or diabetes treatment) [19] was 15.6% in men (13.7% in housing level 1 and 16.9% in housing level 2) and 22.5% in women (20.7% in housing level 1 and 23.7% in housing level 2), which was much higher than the national prevalence estimated by the WHO (men 8.6%; women 7.4%) [23]. Only 4.5% of men and 5.4% of women showed diabetic levels of random blood glucose, indicating the unreliability of random blood glucose in screening for diabetes.

The mean value of total cholesterol was 167 mg/dL in men and 174 mg/dL in women, and the mean value of HDL cholesterol was as low as 33 mg/dL in men and 38 mg/dL in women. The prevalence of raised total cholesterol (≥190 mg/dL or on medication) was 25.7% in men and 34.0% in women. The high-risk range of low-level HDL cholesterol (<40 mg/dL) [20] was 73.2% in men and 55.7% in women, and the high-risk range of borderline-high- to high-level LDL cholesterol (≥130 mg/dL) [20] was 11.7% in men and 12.6% in women. High-level triglycerides (≥200 mg/dL) [20] were more common in men (32.2%) than women (22.4%).

Regarding the prevalence of physical and biochemical risk factors, such as overweight/obesity, hypertension, diabetes and dyslipidaemia, a significant difference was not found between the housing level 1 and level 2 groups (not shown in tables).

DISCUSSION

This study is the first comprehensive epidemiological survey of various NCD risk factors, including HbA1c, among the urban poor in Bangladesh, who are considered to be an underserved high-risk population.

We found that the overweight/obesity prevalence of both men and women was higher than the estimated national prevalence. The overweight/obesity prevalence in women was as high as 39.2%, which could be attributed to the sedentary lifestyle of urban women [25]. Overweight/obesity and underweight were equally prevalent in men, reflecting their socio-economic situation: many men still had to be involved in hard physical labour [26], while some men could afford to eat well. Our findings suggested that both overweight/obesity and underweight should be addressed simultaneously.

The high prevalence of an increased waist-hip ratio in both men and women and increased waist circumference in women indicated high risks of metabolic syndrome among the urban poor. However, further studies are needed to identify appropriate cut-off points and clinical implications of BMI, waist circumference, and waist-hip ratio in Bangladesh considering the discrepancy between waist circumference and waist-hip ratio in men.

The prevalence of diabetes in both housing levels and in both genders was much higher than the WHO-estimated national prevalence [23] and the prevalence findings from the 2006 STEPS survey (men 7.6%; women 2.8%) [10]. The findings of our study were in line with the trend of increasing prevalence reported elsewhere [23]; therefore, diabetes prevalence may have increased since the most recent surveys. Diabetes prevalence among the poor may be higher than the national average, indicating an association between low socio-economic status and increased diabetes prevalence, as shown in studies conducted in high-income countries [27, 28]. The higher diabetes prevalence among the urban poor may be attributed to childhood undernutrition, but further investigation is needed.

Diabetes prevalence was higher in women than men, contrary to the findings of the 2006 survey. The urban poor women may be more prone to diabetes than men, since gender differences in diabetes prevalence may vary depending on socio-economic situations [29]. However, the higher HbA1c levels in women compared to men might have been due to the higher prevalence of anaemia (haemoglobin <11 mg/dL) [30] in women (14.8%) than men (1.8%), which was reported to shift HbA1c values towards the higher end [31-34]. In our study, we used the WHO-recommended HbA1c cut-off point [35], but caution is needed given the high anaemia prevalence. Further studies are needed to fully understand and interpret HbA1c values in low- and lower-middle-income countries.

Our study is the first population-based survey of blood lipid profiles of the urban poor in Bangladesh. A high-risk range of low HDL cholesterol was highly prevalent, but desirable ranges of both low total cholesterol and LDL cholesterol were highly prevalent as well. These findings were consistent with the findings of a previous study of a rural population, although a desirable range of low LDL cholesterol was more prevalent in our study than in the previous study [12]. The clinical implications of low levels of HDL and LDL cholesterol in this population need to be investigated further. The relatively high prevalence of high-level triglycerides might be overestimated, since random blood samples were used.

A high prevalence of tobacco use was confirmed in this study. This finding is consistent with those of previous studies [36, 37]. Chewing tobacco products seemed to be culturally tolerated, as evident in the finding that women often chewed tobacco but refrained from smoking tobacco. Different approaches for men and women are needed for tobacco control.

Approximately 80% of the participants added table salt to their meals, although their meals were already cooked and seasoned with salt. Further studies are needed to determine the amount of salt intake in this population, since we did not measure total salt intake. Our qualitative study found that the community residents sprinkled table salt on rice because they liked the salty taste and served salt with meals for welcoming guests [16]. While salt reduction is known to be a cost-effective strategy to prevent cardiovascular diseases [38, 39], it is difficult to modify the dietary habits of individuals in a short time period. Thus, a long-term community-wide campaign to modify the diets of community residents is necessary, as shown in successful model programs in Japan [40, 41].

The strength of this study is that we targeted the urban poor, an underserved high-risk population, using representative sampling methods. Through analysing blood samples using high-performance automatic equipment in a reliable clinical laboratory rather than using portable devices often used in STEPS surveys, we were able to measure low levels of glucose and total cholesterol, as well as HDL and LDL cholesterol, triglycerides, HbA1c and complete blood count. However, this study has several limitations. First, we targeted only one urban poor community, which may not represent the nationwide situation. Second, we could not measure fasting blood samples. While random blood glucose values were unreliable in screening for diabetes, we found that measuring HbA1c may be a viable alternative.

In conclusion, the current survey revealed a high prevalence of NCD risk factors among the urban poor in Bangladesh. Diabetes, dyslipidaemia, hypertension, tobacco use, and both overweight and underweight were prevalent, indicating the dual burden among the urban poor. Our findings can serve as baseline epidemiological data and help policymakers develop appropriate NCD control strategies.

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Competing interests None declared.

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Table 1. Demographic and behavioural characteristics of participants by gender and household wealth status

	Men			Women			*p* for
Household wealth status	Housing level 1	Housing level 2	All [a]	Housing level 1	Housing level 2	All [a]	gender difference [b]
Number	674	684	1358	615	578	1193	
Age group of years (%)							0.920
18-24	19.4	14.9	16.7	17.7	16.1	16.7	
25-34	35.0	32.9	33.7	37.1	31.0	33.4	
35-44	26.6	25.6	26.0	24.7	28.9	27.3	
45-54	13.9	15.9	15.2	13.7	14.9	14.4	
55-64	5.0	10.7	8.5	6.8	9.2	8.2	
mean (95% CI) [c]	34.4 (33.7-35.0)	36.8 (36.0-37.5)	35.8 (35.3-36.3)	34.3 (33.6-35.0)	36.4 (35.6-37.2)	35.6 (35.0-36.1)	0.549
Years of education (%)							<0.001
none	22.0	32.6	28.4	31.5	45.0	39.7	
1-4	10.5	17.4	14.7	15.9	23.0	20.2	
5-7	24.5	19.6	21.5	29.6	18.3	22.8	
8-9	20.7	16.5	18.1	13.2	8.5	10.3	
≥10	22.3	13.9	17.2	9.8	5.2	7.0	
Religion (%)							0.365
Islam	98.7	96.3	97.3	98.9	97.1	97.8	
Hinduism	1.3	3.7	2.7	1.1	2.9	2.2	
Marital status (%)							<0.001
unmarried	15.4	13.6	14.3	0.7	1.4	1.1	
married	84.6	85.8	85.3	90.2	85.3	87.2	
others	0.0	0.6	0.4	9.1	13.3	11.7	
Occupation (%)							<0.001
employed	22.8	13.6	17.2	17.4	14.0	15.3	
self-employed	44.2	43.1	43.6	3.6	13.3	9.5	
day labor	23.7	30.0	27.5	2.0	7.1	5.1	
homemaker	0.3	0.1	0.2	75.8	64.4	68.8	
others	8.9	13.2	11.5	1.3	1.2	1.2	
Any form of tobacco (%)							<0.001
non-user	39.3	30.8	34.2	84.2	68.2	74.5	

ex-user	6.1	5.0	5.4	1.0	2.8	2.1	
current user	54.6	64.2	60.4	14.8	29.1	23.5	
Tobacco smoking (%)							<0.001
non-smoker	43.6	38.7	40.7	99.5	98.1	98.7	
ex-smoker	7.7	5.4	6.3	0.5	1.9	1.3	
current smoker	48.7	55.8	53.0	0.0	0.0	0.0	
Smokeless tobacco chewing (%)							<0.001
non-user	87.8	78.4	82.1	84.6	68.9	75.0	
ex-user	0.6	2.3	1.7	0.7	2.1	1.5	
current user	11.6	19.3	16.3	14.8	29.1	23.5	
Alcohol drinking (%)							<0.001
non-drinker	95.4	97.7	96.8	100.0	100.0	100.0	
current drinker	4.6	2.3	3.2	0.0	0.0	0.0	
Fruit/vegetable intake, servings per day (%)							<0.001
<1	7.3	6.9	7.1	3.3	16.5	11.3	
1-2.9	61.7	67.1	65.0	57.2	72.6	66.6	
3-4.9	31.0	24.5	27.1	31.7	10.6	18.9	
≥5	0.0	1.5	0.9	7.8	0.3	3.3	
Adding salt at the table (%)							<0.001
always	70.2	46.6	55.9	67.0	41.0	51.2	
often	5.9	13.3	10.4	1.6	28.5	18.0	
sometimes	5.8	17.4	12.8	10.7	9.2	9.8	
never	18.1	22.7	20.9	20.7	21.3	21.0	
Total physical activity, MET minutes per week (%)							<0.001
<600	30.4	19.0	23.5	83.9	51.4	64.2	
600-2999	38.3	26.9	31.4	14.8	44.5	32.8	
≥3000	31.3	54.1	45.1	1.3	4.2	3.0	

Abbreviations: CI, confidence interval of mean; MET, metabolic equivalent

[a] Weighted based on the sampling design.

[b] Gender differences between all men and all women were tested with a chi-squared test and t-test as appropriate.

[c] Finite population correction was applied to the calculation of 95% CIs for mean age.

Table 2. Physical and biochemical characteristics of participants by gender and household wealth status

	Men			Women			
Household wealth status	Housing level 1	Housing level 2	All [a]	Housing level 1	Housing level 2	All [a]	*p* for gender difference [b]
Number	504	504	1008	498	503	1001	
Body mass index, kg/m^2 (%)							<0.001
<18.5	18.5	22.6	21.0	7.2	7.0	7.1	
18.5-24.9	60.3	59.9	60.1	53.4	53.9	53.7	
25-29.9	19.2	15.9	17.2	30.9	29.4	30.0	
≥30	2.0	1.6	1.7	8.4	9.7	9.2	
mean (95% CI) [c]	21.9 (14.1-29.7)	21.6 (15.1-28.0)	21.7 (14.7-28.8)	24.2 (14.4-33.9)	24.1 (16.3-31.9)	24.1 (15.5-32.7)	<0.001
Waist circumference, cm (%)							<0.001
≤80	53.8	56.0	55.1	47.0	46.5	46.7	
81-90	29.6	28.2	28.7	29.5	34.2	32.4	
91-94	7.5	6.5	6.9	9.0	7.8	8.2	
>94	9.1	9.3	9.2	14.5	11.5	12.6	
mean (95% CI) [c]	80.2 (58.2-102.1)	79.6 (61.2-98.0)	79.8 (59.9-99.8)	82.2 (55.2-109.2)	81.9 (62.5-101.4)	82.0 (59.7-104.4)	<0.001
Waist-hip ratio (%)							<0.001
<0.8	2.6	4.2	3.5	5.4	5.8	5.6	
0.8-0.84	11.3	9.5	10.2	13.9	14.5	14.3	
0.85-0.89	24.0	20.4	21.8	22.9	27.5	25.8	
≥0.9	62.1	65.9	64.4	57.8	52.2	54.3	
mean (95% CI) [c]	0.92 (0.78-1.06)	0.93 (0.81-1.05)	0.93 (0.80-1.05)	0.91 (0.75-1.07)	0.90 (0.78-1.03)	0.91 (0.77-1.04)	<0.001
Systolic blood pressure, mmHg (%)							<0.001
<120	55.6	56.9	56.4	67.9	65.4	66.3	
120-129	23.2	18.5	20.3	14.7	14.9	14.8	
130-139	10.7	11.9	11.4	7.8	8.2	8.0	
≥140	10.5	12.7	11.8	9.6	11.5	10.8	
mean (95% CI) [c]	120 (87-152)	121 (89-153)	121 (88-153)	115 (73-158)	116 (83-149)	116 (79-153)	<0.001
Diastolic blood pressure, mmHg (%)							0.475
<80	58.9	59.7	59.4	60.6	63.2	62.3	
80-84	15.9	14.1	14.8	14.1	13.1	13.5	

85-89	11.5	11.5	11.5	10.0	10.5	10.3	
≥90	13.7	14.7	14.3	15.3	13.1	13.9	
mean (95% CI) [c]	78 (55-101)	79 (58-99)	78 (57-100)	78 (51-105)	78 (58-98)	78 (55-101)	0.197
HbA1c, % (%)							<0.001
<5.7	51.4	48.8	49.8	49.6	46.3	47.6	
5.7-6.4	35.1	34.5	34.8	31.1	30.6	30.8	
≥6.5	13.5	16.7	15.4	19.3	23.1	21.6	
mean (95% CI) [cd]	5.8 (4.4-7.6)	5.8 (4.2-8.1)	5.8 (4.3-7.8)	5.9 (4.1-8.4)	6.0 (4.1-8.6)	5.9 (4.1-8.6)	0.004
Random blood glucose, mg/dL (%)							0.261
<140	93.3	91.3	92.0	89.2	90.9	90.0	
140-199	3.6	3.4	3.5	5.6	3.6	4.3	
≥200	3.2	5.4	4.5	5.2	5.6	5.4	
mean (95% CI) [cd]	98 (55-175)	101 (52-196)	100 (55-183)	102 (54-196)	102 (55-189)	102 (53-197)	0.123
Total cholesterol, mg/dL (%)							<0.001
<150	36.1	36.5	36.4	27.7	30.2	29.3	
150-189	40.1	37.7	38.6	37.1	38.2	37.8	
190-199	4.4	6.9	5.9	8.6	8.3	8.5	
200-239	15.1	14.7	14.8	19.9	17.7	18.5	
≥240	4.4	4.2	4.2	6.6	5.6	6.0	
mean (95% CI) [c]	166 (85-248)	167 (101-232)	167 (94-239)	176 (82-270)	173 (96-249)	174 (90-258)	<0.001
HDL cholesterol, mg/dL (%)							<0.001
<40	73.8	72.8	73.2	57.1	54.9	55.7	
40-49	20.4	19.2	19.7	27.2	27.4	27.3	
≥50	5.8	7.9	7.1	15.7	17.7	16.9	
mean (95% CI) [cd]	33 (19-57)	33 (19-57)	33 (20-56)	38 (19-65)	38 (22-67)	38 (22-68)	<0.001
LDL cholesterol, mg/dL (%)							0.830
<100	54.3	58.3	56.7	51.4	57.4	55.1	
100-129	34.2	30.0	31.6	34.5	31.1	32.4	
130-159	9.5	9.3	9.4	11.0	9.8	10.2	
≥160	2.0	2.4	2.2	3.0	1.8	2.3	
mean (95% CI) [c]	98 (39-156)	96 (49-143)	97 (45-149)	101 (35-167)	98 (40-156)	99 (37-161)	0.063
Triglycerides, mg/dL (%)							<0.001

<100	24.6	30.2	28.0	36.7	36.0	36.3	
100-149	25.0	22.8	23.7	25.5	24.7	25.0	
150-199	19.4	14.1	16.2	15.5	16.9	16.4	
≥200	31.0	32.9	32.2	22.3	22.5	22.4	
mean (95% CI) [cd]	150 (48-473)	151 (42-539)	151 (46-489)	125 (41-379)	128 (38-432)	127 (37-432)	<0.001
Haemoglobin, mg/dL (%)							<0.001
<11	1.6	2.0	1.8	13.9	15.3	14.8	
11-11.9	3.6	3.6	3.6	25.3	29.0	27.6	
12-12.9	6.2	9.5	8.2	39.0	33.2	35.4	
13-16.9	88.1	84.1	85.7	21.9	22.5	22.2	
≥17	0.6	0.8	0.7	0.0	0.0	0.0	
mean (95% CI) [c]	14.3 (11.5-17.0)	14.2 (11.8-16.6)	14.2 (11.6-16.8)	12.1 (9.3-14.9)	12.0 (9.7-14.3)	12.0 (9.5-14.6)	<0.001

Abbreviations: CI, confidence interval; HbA1c, glycated haemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Weighted based on the sampling design.

[b] Gender differences between all men and all women were tested with a chi-squared test or t-test as appropriate.

[c] Finite population correction was applied to the calculation of 95% CIs.

d Log-transformed data were used

Table 3. Prevalence of physical and biochemical risk factors of non-communicable diseases by gender and household wealth status, % (95% CI) [a]

Household wealth status	Men: Housing level 1	Men: Housing level 2	Men: All [b]	Women: Housing level 1	Women: Housing level 2	Women: All [b]	p for gender difference [c]
Overweight or obesity BMI ≥25 kg/m^2	21.2 (18.3-24.2)	17.5 (14.5-20.4)	18.9 (16.8-21.1)	39.4 (36.0-42.7)	39.2 (35.4-42.9)	39.2 (36.6-41.9)	<0.001
Obesity BMI ≥30 kg/m^2	2.0 (1.0-3.0)	1.6 (0.6-2.6)	1.7 (1.0-2.5)	8.4 (6.5-10.3)	9.7 (7.4-12.0)	9.2 (7.7-10.8)	<0.001
Large waist circumference							
men >90 cm, women >80 cm	16.7 (14.0-19.4)	15.9 (13.0-18.7)	16.2 (14.2-18.2)	53.0 (49.6-56.4)	53.5 (49.7-57.3)	53.3 (50.6-56.0)	<0.001
men >94 cm, women >80 cm	9.1 (7.0-11.2)	9.3 (7.1-11.6)	9.2 (7.6-10.8)	53.0 (49.6-56.4)	53.5 (49.7-57.3)	53.3 (50.6-56.0)	<0.001
Large waist-hip ratio men ≥0.9, women ≥0.85	62.1 (58.6-65.6)	65.9 (62.2-69.6)	64.4 (61.8-67.0)	80.7 (78.0-83.4)	79.7 (76.6-82.8)	80.1 (77.9-82.2)	<0.001
Hypertension							
SBP ≥140 mmHg or DBP ≥90 mmHg	16.9 (14.2-19.6)	18.1 (15.1-21.1)	17.6 (15.5-19.7)	16.5 (13.9-19.0)	16.7 (13.8-19.6)	16.6 (14.6-18.6)	0.512
SBP ≥140 mmHg or DBP ≥90 mmHg or on medication	18.3 (15.5-21.0)	18.8 (15.8-21.9)	18.6 (16.5-20.8)	20.3 (17.5-23.0)	20.9 (17.8-24.0)	20.7 (18.5-22.9)	0.195
Diabetes: HbA1c ≥6.5% or random blood glucose ≥200 mg/dL or diabetes treatment.	13.7 (11.2-16.2)	16.9 (13.9-19.8)	15.6 (13.6-17.6)	20.7 (17.9-23.5)	23.7 (20.4-26.9)	22.5 (20.3-24.8)	<0.001
Raised total cholesterol							
≥190 mg/dL	23.8 (20.7-26.9)	25.8 (22.4-29.2)	25.0 (22.6-27.4)	35.1 (31.9-38.4)	31.6 (28.1-35.2)	32.9 (30.4-35.5)	<0.001
≥190 mg/dL or on medication	24.4	26.6	25.7	35.9	32.8	34.0	0.001

	(21.3-27.5)	(23.1-30.0)	(23.3-28.1)	(32.6-39.2)	(29.2-36.4)	(31.4-36.5)	
Low HDL cholesterol							
both men and women <40 mg/dL	73.8 (70.6-77.0)	72.8 (69.4-76.3)	73.2 (70.8-75.7)	57.1 (53.7-60.6)	54.9 (51.1-58.7)	55.7 (53.0-58.4)	<0.001
men <40 mg/dL, women <50 mg/dL	73.8 (70.6-77.0)	72.8 (69.4-76.3)	73.2 (70.8-75.7)	84.1 (81.6-86.6)	82.3 (79.4-85.2)	83.0 (80.9-85.0)	<0.001
Raised LDL cholesterol ≥130 mg/dL	11.7 (9.4-14.0)	11.7 (9.2-14.2)	11.7 (9.9-13.5)	14.1 (11.7-16.4)	11.7 (9.3-14.2)	12.6 (10.8-14.4)	0.484
Raised triglycerides ≥150 mg/dL	50.4 (46.8-54.0)	47.0 (43.1-50.9)	48.4 (45.6-51.1)	37.8 (34.4-41.1)	39.4 (35.6-43.1)	38.8 (36.1-41.4)	<0.001

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HbA1c, glycated haemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein

[a] Finite population correction was applied to the calculation of 95% CIs for each proportion.

[b] Weighted based on the sampling design

[c] Gender differences between all men and all women were tested with a chi-squared test.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2–3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5–6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6–10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6–10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6–8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10–11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9–10
Bias	9	Describe any efforts to address potential sources of bias	7–11
Study size	10	Explain how the study size was arrived at	6–8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10–11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7–8, 10–11
		(*b*) Describe any methods used to examine subgroups and interactions	10–11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7–8, 10–11
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7–8, 11–12
		(b) Give reasons for non-participation at each stage	7–8
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11–12 24–25
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	11–14

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	10–11, 26–30
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	2–4, 14–16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4, 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14–16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17